Aalto-yliopisto

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The social and distributional impacts of transport in Helsinki region

What, how, and whom to assess

Diplomityö, joka on jätetty opinnäytteenä tarkastettavaksi diplomi-insinöörin tutkintoa varten.

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Diplomityön tiivistelmä

Tekijä Taru Pakkanen

Työn nimi Liikenteen sosiaaliset vaikutukset ja vaikutusten jakautuminen Helsingin seudulla — mitä, miten ja ketä arvioida

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Tiivistelmä

Tutkimuksen tavoitteena on ymmärtää ja huomioida liikenteen sosiaalisia vaikutuksia ja vaikutusten jakautumista, jotta liikennesektorin tulevaisuuden haasteisiin pystytään vastaamaan jatkossa kokonaisvaltaisemmin. Tutkimus on osa MAL-suunnittelun liikennejärjestelmäsuunnitelman vaikutusten arvioinnin kehittämisprojektia. Työ kytkeytyy MAL-suunnittelun menetelmien kehittämiseen ja tuottaa syötteitä vaikutusten arviointiin.

Tutkimuksessa tarkasteltiin liikenteen sosiaalisia vaikutuksia ja vaikutusten jakautumista Helsingin seudulla. Liikenteen sosiaalisilla vaikutuksilla tarkoitetaan vaikutuksia, jotka positiivisesti tai negatiivisesti, muokkaavat ihmisten tai ryhmien preferenssejä, käytöstä, valintoja, hyvinvointia ja terveyttä. Vaikutusten jakautumisella tarkoitetaan liikenteen toimenpiteiden vaikutusten jakautumista alueellisesti, ajallisesti ja sosiodemografisesti.

Tutkimus koostui liikenteen sosiaalisten vaikutusten arviointikehikon ja vaikutusten jakautumisen tarkistuslistan suunnittelusta, jotka muodostettiin yhteistyössä seudun asiantuntijoiden kanssa. Arviointikehikko esittää liikenteen sosiaaliset vaikutukset, joita MAL-suunnittelutasolla tulisi arvioida jatkossa. Tarkistuslista esittää vaikutusten jakautumisen alueellisesti, ajallisesti ja sosiodemografisesti. Arvioinnissa tulisi painottaa kaikista haavoittuvimpien alueiden, väestöryhmien ja ajankohtien tunnistamista.

Tutkimuksessa demonstroitiin liikenteen sosiaalisten vaikutusten ja vaikutusten jakautumisen arviointia tapaustutkimuksessa. Tapaustutkimuksessa analysoitiin MAL 2019 -suunnitelman vaikutuksia joukkoliikenteen yleistetyn matkavastuksen ja kestävien kulkumuotojen saavutettavuuden muutoksiin alueittain ja tulotasoittain. Tutkimuksessa todettiin, että MAL 2019 -suunnitelman hyödyt jakautuvat tulotasoittain tasaisesti. Suunnitelma hyödyttää alueellisesti koko seutua, joskin Kuuma-seutu hyötyy suunnitelmasta eniten.

Avainsanat Liikenne, maankäyttö, liikennejärjestelmä, seudullinen suunnittelu, MAL, vaikutusarviointi, sosiaaliset vaikutukset, jakautumisvaikutukset,

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Abstract of master's thesis

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Abstract

The aim of the thesis is to understand and recognize the social and distributional impacts of transport so that the transport planning sector would be more equipped to answer to the challenges of the future comprehensively. The thesis is part of an impact assessment development project for the transport system planning of Helsinki region's MAL planning process.

The thesis examined the social and distributional impacts of transport in Helsinki region. The social impacts of transport refer to impacts that either positively or negatively change individual's or group's preferences, choices, behaviour, wellbeing, and health. The distributional impacts refer to the impact distribution created by transport measures which have effects spatially, temporally, and socio-demographically.

The thesis formulated a social impact assessment matrix and a distributional impact assessment checklist which were designed in co-operation with the regional MAL planning experts. The social impact assessment matrix presents the impacts which MAL planning process should assess in the future. The checklist presents the distribution of impacts spatially, temporally, and socio-demographically. The checklist should be utilized as a case-by-case tool so that the planner would determine and decide which spatial areas and which socio-demographic groups to assess during each assessment. The assessment should emphasize the most vulnerable and least disadvantaged.

The thesis included a case study which analysed the distributional impacts of MAL 2019 plan on changes of workforce accessibility on sustainable modes of transport and on generalized trip friction by public transport both spatially and among income levels. The study discovered that the benefits of MAL 2019 plan were distributed evenly among income levels. The plan benefits the whole Helsinki region, albeit Kuuma region benefits the most.

Keywords Transport, land use, transport system, regional planning, MAL, impact assessment, social impacts, distributional impacts

Foreword

The aim of the thesis was to understand and recognize the social and distributional impacts of transport so that the transport system plannig practice in Helsinki region would be more equipped to answer to the challenges of the future. The thesis was financed by HSL since the thesis was a part of the HSL's MAL impact assessment development project. The thesis steering group in HSL included Sini Puntanen, Aarno Kononen, Heikki Palomäki, and Reetta Koskela. The thesis was instructed by Reetta Koskela from HSL and Taina Haapamäki from FLOU Oy. The thesis was supervised by Miloš Mladenović from Aalto University.

The thesis process was intensive and very educational. Thank you to HSL's transport system planning group for the great discussions and for the opportunity. Thank you to the comrades at FLOU Oy, especially to Sami Mäkinen and Touko Väänänen for the endless help and support during times of darkness. Special thanks for both Taina Haapamäki and Miloš Mladenović for essential support and fresh viewpoints.

Espoo 24.04.2020

Taru Pakkanen

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Abbreviations

HSL	Helsinki region transport authority, Helsingin seudun liikenne
MAL	Land use, housing, transport Maankäyttö, asuminen, liikenne
MAL 2019	Land Use, Housing, and Transport plan 2019, Maankäytön, Asumisen ja Liikenteen suunnitelma 2019

1 Introduction

Integrating viewpoints of sustainable development into transport system planning has increased its momentum in recent years due to issues such as climate change and resource deficiency. The transport system planning practice has until lately focused mostly on assessing economic and environmental impacts of transport, for the reasons of promoting economic growth in cities and decreasing transport sector CO_2 emissions, and thus leaving the social impacts of transport at bay. Since transport system planning notably creates effects that have both social and distributional impacts, for the transport system planning to be de facto sustainable, the social and distributional impacts of transport should be accounted for on top of the economic and environmental impacts. Considering the intensifying need to reduce CO_2 emissions of transport sector combined with a continuing resource scarcity, it is important to consider the social and distributional impacts of the proposed policy measures in order to understand the distribution and the social dimension of the impacts. This is important for the building of all-around sustainable transport systems.

Throughout 20th century, transport system planning goals were almost entirely mobility-based with a focus on time savings, security, and congestion reduction (Manaugh et al. 2015). Since the beginning of the 21st century, however, the social and distributional impacts of transport started gaining recognition due to environmental and social movements' effect on governments (Jones and Lucas 2012; Preston and Rajé 2007). The New Labour government in UK developed the Equality Act and the Public Sector Equality Duty which forced public bodies, including public transport authorities, to consider all individuals in carrying out their day-to-day work in shaping policy which has resulted the authorities to focus on the distributional impacts of transport (Markovich and Lucas 2011). These two pieces of legislation resulted in, for example, the London Plan's Equality Impact Assessment (Transport for London 2017). Similar developments have taken place in the city of Vienna which assesses gender-related impacts of all its urban planning related policy initiatives (City of Vienna 2013). It is noteworthy that these assessments focus mostly on the distribution of policy implications. The study of health impact assessments has also gained popularity in the 2000's which has since been followed by the concept of social impact assessments (SIA).

This study focuses on the social and distributional impacts of transport system planning in the context of Helsinki region. Helsinki region transport system planning is produced by Helsinki region transport authority (HSL) in co-operation with Helsinki region's 15 cities and municipalities. The current transport system plan was developed in co-operation with the regional land use and housing plans as a comprehensive Land Use, Housing and Transport Plan (MAL 2019) which was approved in spring 2019. MAL 2019 plan results in a MAL agreement negotiated between Helsinki region's 15 cities and municipalities and the state.

The MAL planning process aims for cooperation. As already stated, it is done in close co-operation with the cities and municipalities of the Helsinki region and HSL. On top of that, the process includes representatives from the Regional Council of Uusimaa and the Centre for Economic Development, Transport and the Environment for Uusimaa. The state has also representatives in the process from the Ministry of Transport and Communications, the Ministry of the Environment, the Finnish Transport and Communications Agency, and the Finnish Transport Infrastructure Agency. In order to include the residents

of the region in the process, the planning process organized two all-day seminars for the regional communal representatives from the cities and municipalities that had volunteered to be a part of the process. (HSL 2019b.) The MAL planning process thus aims for cooperation and participation, especially in the long run. Cooperation among actors and representatives is considered essential for the planning process and the region in general.

The plan itself is a road map for "an attractive, healthy, low-emission, and vibrant future for the Helsinki region" which sets out concrete measures for a 2030 time frame. (HSL 2019.) The MAL 2019 is also the regional equivalent for the sustainable urban mobility plan (SUMP).

Figure 1. The MAL 2019 objectives. Source HSL 2019.

The MAL 2019 plan includes a comprehensive impact assessment which was closely integrated with the planning process. The planning process included three planning rounds which were each followed by a round of impact assessments. The set-up of the process enabled the plan to improve during the planning process itself for the politically decided plan objectives to be met. As such, the impact assessing was connected to the objectives, their indicators, and target levels (figure 1 and figure 2). The ex-ante impact assessing included many different analyses of the proposed transport policy and infrastructure measures with a stronger focus on economic analyses (e.g. cost benefit analysis and workforce accessibility analysis) and environmental analyses (e.g. analysis on the reductions of CO_2 emissions). Part of the impact assessments were required by the Finnish environmental impact assessment legislation (SOVA legislation). Since the determinative objective of the MAL 2019 plan was to reduce the transport sector's CO_2 emissions in the region by 50% until 2030 from the 2005 baseline, the impact assessment process steered the plan towards the reductions and focused on the environmental impacts of the plan (HSL 2019b.)

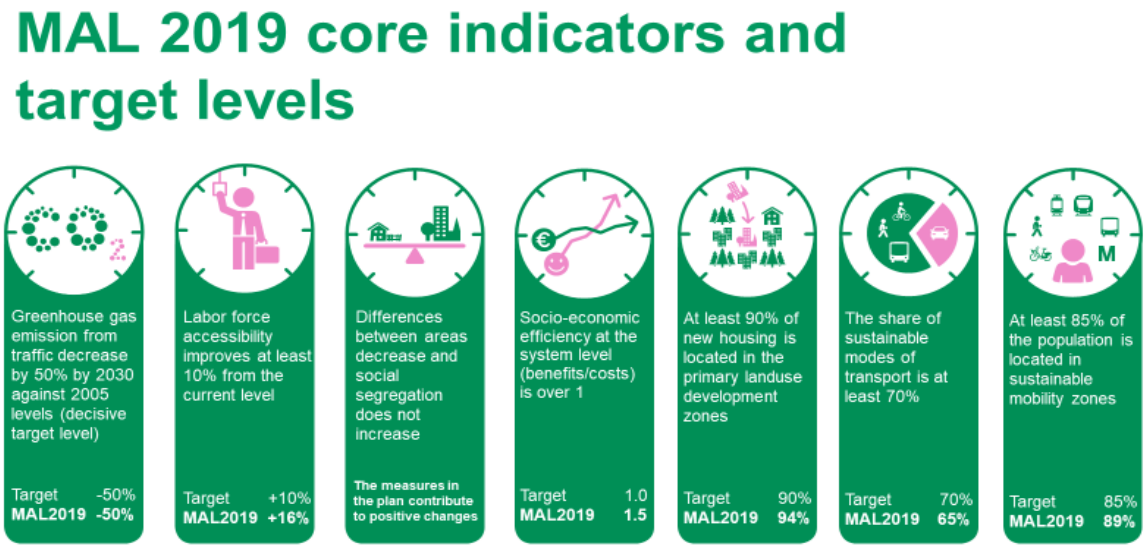

Figure 2. MAL 2019 core indicators and target levels. Source HSL 2019.

This study is part of a process to further develop the MAL planning related to the transport system impact assessment. Helsinki region's MAL planning process is currently slowly preparing for the future MAL planning cycle and has started a project to improve its impact assessment process. HSL aims to advance the assessing of social and distributional impacts. The aim is to understand and consider how transport impacts the residents and what is the impact of transport measures on equity and equality of the transport system. The aim of the project is to comprehend different dimensions of transport and how they can be assessed. It is the intention of this research to explore how the social and distributional impacts of transport can be considered in planning and in impact assessing, in addition to the more traditional assessment measures. The research questions of this study are the following:

- What are the social impacts of transport?
- What are the social impacts of transport in the context of Helsinki region's MAL planning?
- How can the social impacts of transport be assessed on both strategic and project levels?

The research project consists of multiple sections and is done in close co-operation with MAL planning process participants from different areas of the region. The project starts with a background section consisting of a comprehensive literature review where the focus is on the social and distributional impacts of transport. Since the thesis is a part of HSL's impact assessment development project, the thesis considers the theories of organizational learning and academic literature on integrative land use, housing and transport planning support systems (PSS).

The thesis is set in between planning theory and planning practice. It seeks to consider the theories of planning and the academic views on social and distributional impacts of transport while practicing and developing actual planning practice. This study is only a part of an impact assessment development project at HSL which will continue after this thesis is done. This study aims at building a base for the development process to move

forward after the thesis project ends. This is done by practicing the methods of change-oriented research design science approach and assessing how different methods can be used to analyze the social and distributional impacts of transport.

This research topic continues the discussion on the social dimension of transport which has been examined before on a national level in the context of social sustainability, social equity, and transport poverty (Heltimo 2003; Tiehallinto 2001; Tiikkaja et al. 2018). This is, as far as the writer is aware, the first research on the social impacts of transport in the Helsinki region's context. At the same time, this study continues the quite extensive impact assessment development literature which has been proceeded formerly in both national and regional context previously (Mild and Metsäranta 2014; HSL 2017c; Liimatainen et al. 2017). In addition, this research utilizes the literature on organizational learning to understand the process of impact assessment development and as such, may increase to the discussion on organizational learning.

This thesis is organized as follows. Chapter 2 considers the background literature on mobility behavior, the social and distributional impacts of transport, the impact assessment process of MAL planning, and organizational learning. Chapter 3 immerses into the methodology of the thesis and considers the change-oriented research design science approach, the set-up of the workshops, the thematic analysis, and the methods used in the case study. Chapter 4 outlines the results of the thesis including the results from the workshops and the case study. Chapter 4 also includes the design of the matrix for the social impacts of transport and the checklist for the distributional impacts of transport. Chapter 5 presents the discussion of the thesis which includes the main findings, the main development ideas, and the recommendations for future impact assessment processes. Chapter 6 concludes the thesis with a summary of the study and ends the discussion with a few viewpoints on the future of planning.

2 Background

This background section of the report dives into the social dimension of transportation. The section 2.1 investigates the different views on mobility behavior, the social impacts of transport, and the distributive impacts of transport. The section also considers a discussion of distribution of costs and benefits from the perspective of equity and fairness.

The section 2.2 examines the impact assessment process from the viewpoints of the state and HSL. The section considers how impact assessment is currently done and how has HSL already considered the social and distributional impacts of transport during previous rounds of planning.

Considering that the thesis aims at developing the impact assessment process of HSL transport system planning so that the social and distributional implications of transport are also considered, the background section also looks into the theory of organizational learning and considers the MAL planning process as a process of organizational learning.

2.1 The social dimension of transport

2.1.1 Mobility behaviour

In order to comprehend the social dimension of transport, one must first consider why do individuals move in the first place, and what is the reason behind traveling. Movement could be said to be very central to human behaviour, and therefore, the freedom of movement is guaranteed in the basic rights of citizens in modern, western democracies. This section considers some of the different viewpoints on mobility behaviour and aims at an overall, yet compact and undeniably scarce, understanding of the concept.

Mobility itself refers to the ability or ease of moving around, or movement of people and goods. The everyday life of individuals tends to revolve around friends, family, work, school, recreational activities, and other necessary errands. The distribution of time and space of these commitments and opportunities shapes the individuals' mobility and activity. The size of this activity determines the individual's need of transport services. (Donaghy et al. 2004.) This relationship between space and mobility is called accessibility. Accessibility refers to the ease of reaching opportunities or locations from one origin to several destinations or from several origins to one destination. (Litman 2011.) Whether the individual lives close to their everyday commitments, he/her can use active modes of travel to move to locations. However, the further the commitments are situated, the more necessary it is to use a car or other motorized vehicles to enable access.

Mobility behaviour is connected to individual's needs and wants as well as situational constraints (Donaghy et al. 2004). The need for movement and travel has sometimes been presented through Maslow's hierarchy of needs (figure 3). The figure portrays a viewpoint on the individual's intrinsic needs and behavioural motivation. The categories are basic needs (physiological and safety needs), psychological needs (esteem and belongingness needs), and self-fulfilment needs (self-actualization). (Maslow 1943.) Mobility enables fulfilling many of the intrinsic needs of individuals. For example, transport planning can enable the basic needs of individuals quite straightforwardly with making it possible for individuals to access local stores for food supply. Transport can enable also psychological needs, such as enabling the meeting of friends, or self-fulfilment needs with

enabling commuting to work, therefore, making it possible for people to fulfil their potential.

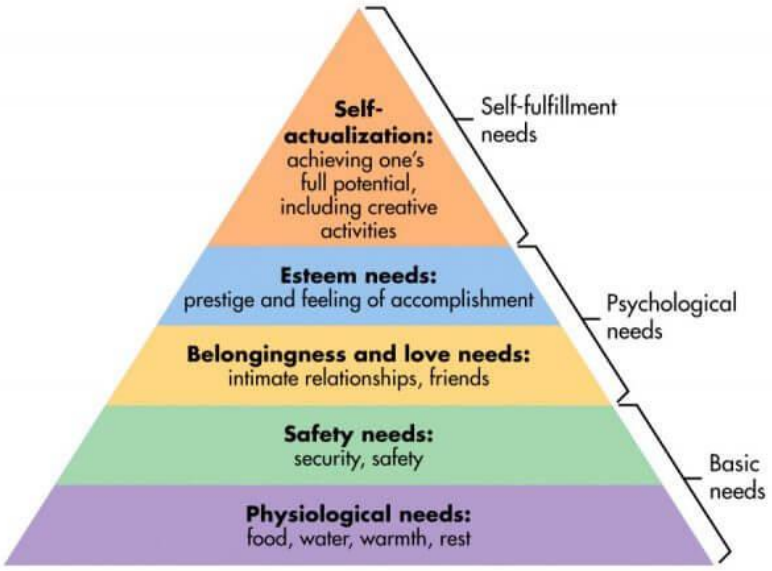

Figure 3. Maslow's hierarchy of needs. Source Maslow 1943.

A similar examination on the different aspects of human life has been made by Martha Nussbaum. She lists ten necessary human capabilities or freedoms which enable types of central human activities: *life; bodily health; bodily integrity; senses, imagination, and thought; emotions; practical reason; affiliation; other species; play;* and *control over one's environment*. Mobility behaviour could be seen to consist of multiple capabilities, such as *bodily integrity* as being able to move freely from place to place (e.g. freedom of movement), and *affiliation* as being able to engage in social interaction (e.g. mobility enabling meeting friends and family face-to-face). (Nussbaum 2000.) Therefore, mobility could be seen to enable central human behaviour.

The mainstream transport planning's perspective on mobility behaviour bases its ideas on the utility maximization principle of microeconomics which reasons that travel choices are based on an assessment of individual's preferences for particular trips or travel modes and the relative costs of making those trips or choosing those travel modes. Travel is seen as derived demand and travel time is considered as a disutility. Travel time is understood in terms of opportunity costs; it is seen as unproductive, and therefore, this time is better transferred to other activities (Te Brömmelstroet n.d.). The idea is that people are rational decisionmakers who are aiming to maximize their own utility, and in this case, to minimize their travel time. Theoretically, the travel time saved allows people to reduce the presumed disutility experienced during travel and it allows them to spend the time doing activities that make them financially and psychologically better off (Delbosc 2012). According to this view, the individuals rationally calculate the costs and benefits of multiple, for example, mode or route choices and adopt the choices which maximize their net benefits, e.g. the fastest route (Van Acker et al. 2010). The idea of minimizing one's travel time relates to travel time budgeting which states that people have a fairly stable time budget for traveling (Zahavi and Talvitie 1980). During this fixed time, individuals will make rational decisions based on travel modes or routes. This mainstream transport planning's perspective on mobility behaviour is widely used and transport system planning usually bases its assumptions on this background.

Despite the current paradigm of mainstream transport planning, transport studies have recently considered mobility behaviour from a much wider perspective: some of the research has focused on mobility behaviour's psychological aspects, others have examined the sociological processes related to mobility. Many of the studies have sought to understand mobility behaviour and examine why individuals travel the way they do, and how could mobility behaviour be altered in order to enable more sustainable mobility (De Vos 2019; Cairns et al. 2014).

The research has focused on the psychological processes related to travel and wellbeing, and the way people perceive their travel (De Vos 2019; Chatterjee et al. 2019; Mokhtarian et al. 2001). Chatterjee et al. (2019) comprised an overview of studies related specifically to commuting and wellbeing. Commuting impacts individual's wellbeing during the journey, immediately after the journey, and over longer term. It creates affective experiences, such as stress, excitement, pleasure, boredom, and control. Commuting is also studied in relation to commute travel satisfaction which is affected by chosen travel mode, travel time, built environment, and travel-related attitudes. (Chatterjee et al. 2019.) Therefore, commuting creates different emotions due to multiple aspects during, immediately after, and over longer term which affect the individual's wellbeing.

De Vos (2019) examined further how the chosen travel mode affects travel satisfaction. Quite unsurprisingly, travel mode is seen to impact travel satisfaction. For example, public transport users are usually most unsatisfied with travel, while travellers using active modes are usually the most satisfied. De Vos argues that the chosen mode does not explain satisfaction completely, and individual's attitudes towards the chosen mode also play a role in impacting the level of travel satisfaction. In addition, the experienced travel satisfaction itself might affect mode choice and travel attitudes more than mode choice affects travel satisfaction. (De Vos 2019). Hence, individual's personal attitudes towards a travel mode already determine their experienced travel satisfaction in advance. Also, the experienced travel satisfaction itself affects, and possibly enhances, individual's attitudes towards a travel mode which then affects the mode choices individual's make.

Van Acker et al. (2010) have also described how travel behaviour is influenced by individual's internal processes, such as reasoned influences, unreasoned influences, and individual's resources (such as financial resources). Reasoned influences are attitudes, beliefs or perceptions, intentions, and preferences which affect the individual's mobility behaviour. (Van Acker et al. 2010.) For example, individual's perception of bus travel factor into their decision of how to commute to work. If the perception is positive, then the odds of commuting by bus are much higher. However, mobility behaviour is also influenced by *unreasoned factors*. Instant behaviour is usually the result of reasoned influences, however, when the behaviour is repeated it becomes a habit. Habits are repetitive action which do not usually require rational decision-making. (ibid.) For example, if an individual is used to commuting to work by bus, they will most likely do so in the future, since the action is already a habit and does not require active decision-making. Therefore, the changing of travel habits requires learning new routines, actively deciding, which can make it rather hard for the individual (ibid).

In addition, mobility behaviour can be examined from a sociological viewpoint. Sociology considers mobility behaviour not from the viewpoint of individual's behaviour nor the viewpoint of microeconomics, but as wider social phenomena. Mobility behaviour in a sociological context is analysed through *travel practices*, in which "practices" work as

units of analysis. Travel practices are recurring individual performances (individual travels by car), which, through multiple instances and repetition, are reproduced over time as societal practices (people travel by car). (Cairns et al. 2014.) In other words, practices can be interpreted to mean usual or customary action (Stephenson et al.). The term travel practice upholds the *materials* related to travel (e.g. vehicles), the competences (e.g. driver's licence), and the meanings related to travel (e.g. the culture related cars) (Cairns et al. 2014). Using practices as units of analysis enables a wider understanding of mobility behaviour, and how everyday activities are influenced by the broader structures of society (Stephenson et al. 2015).

Understanding mobility behaviour requires also examining the changing nature of society, such as, the changes in family structures and the identity creation of consumer society, which both have implications for travel. (Cairns et al. 2014.) Changing family structures may create more travel and different reasons for travel, for example, when children travel in between multiple homes. The identity creation of consumer society relates to how consuming enables and reproduces identities. For example, buying a Tesla may enable and reproduce an identity of sustainable consumer as opposed to buying a Hummer.

Sociologists have especially examined mobility behaviour related to car and highlight the ethical, experiential, and emotional dimensions associated with car use: it's symbolic role in consumption societies, and its role in different cultures. Car usage upholds a unique set of values and meanings, such as, enabling freedom or enabling nurture. The meanings and symbols associated with the car have an independent social construction, for example, car ownership may enable individual's portrayal of themselves or alternatively it can validate individual's role in the society. Car usage can also enable individual's car specific experiences, such as feelings of freedom. (Cairns et al. 2014.) All in all, the different roles attached to car usage are multiple. The role of the car in relation to mobility behaviour is an essential aspect to understand in order to enable a transition to a more sustainable transport system.

Mobility can also be examined from a holistic, multidisciplinary framework that considers the societal, psychological, and built environment factors of mobility. The energy cultures framework was originally designed to examine energy behaviour and why people do not transition to use more sustainable energy options. However, framework has since been applied to multiple fields, such as transport, which I will now consider as *mobility cultures*. The framework offers a systemic representation of key characteristics (of mobility) that can be individually or collectively examined through different research methods, and a model through which these multiple findings can be then considered in an integrated way. (Stephenson et al. 2015.)

The concept of culture is relational and considers how a culture both creates and is reinforced by its material objects. The framework characterizes mobility cultures *as the interactions between norms, practices, and material culture* (figure 4). Material culture refers to the physical evidence of culture including objects, buildings, and infrastructure. In the realms of mobility, this refers to all things related to the *built environment* such as vehicles and infrastructure. Practices refer to the usual or customary action of individuals and the society which span from everyday habitual activities to less frequent process of choosing and acquiring material objects. Norms relate to individual's cognitive expectations, as individual's current practices and material culture, and cognitive aspirations, as related to individual's practices and material culture that are not yet realized. In addition, the aspects are affected by external influences. External influences form the context in

which norms, practices, and built environment are situated. The framework is adaptable and can be applied to different contexts and scales from the individual to global, and to communities and households. For example, it could enable studying the mobility cultures of a suburb or a mobility culture of an individual. (Stephenson et al. 2015; Stephenson 2018.)

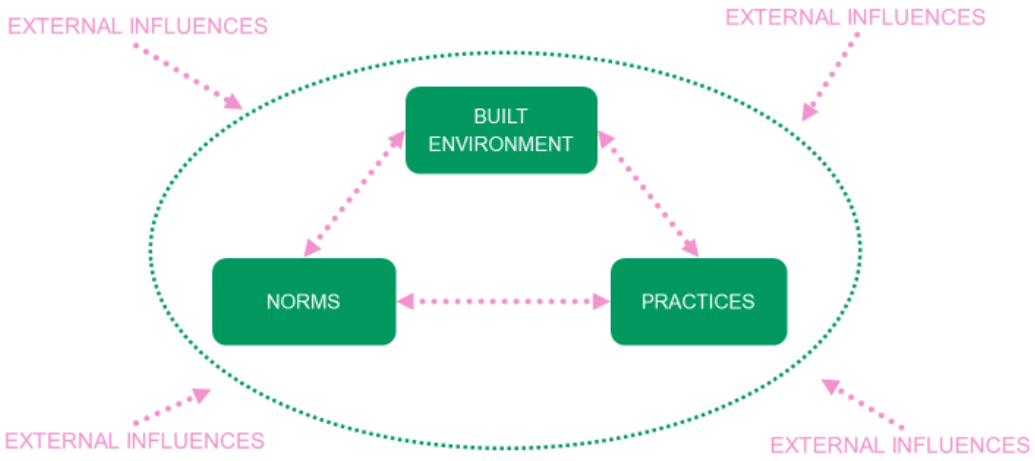

Figure 4. Mobility cultures framework. Source adapted from Stephenson et al. 2015

The framework was founded as a simple tool for thinking, a heuristic, which has been useful in explaining complex systems in a rather simple way. The framework is at the same time a model of behaviour and a theory of behaviour change. As a model of behaviour, it offers an interrelated set of concepts centred on a subject (mobility) and the interrelationships between their norms, practices, and material culture, as well as the external influences as the role of social and institutional setting. As a theory of change, it shows potential in structuring investigation into the variety of ways in which changes in mobility behaviour could be initiated: through subjects themselves, or through changes in external environment. In particular, the framework invites exploration of the cultural formations *underpinning the transition to sustainable outcomes*. (Stephenson et al. 2015; Stephenson 2018.)

To summarize this section, mobility behaviour can be explained by the utility maximization viewpoints of microeconomics, by focusing on the individual's inner processes, and by viewing the bigger societal picture and examining travel practices. It could also be presented through the mobility cultures framework which considers the inner processes of people, the norms, the societal customary actions, the practices, and the surrounding built environment and their interaction with each other and external influences.

Transport system plans are formulated to essentially improve cities, city regions, and wider commuting areas. The plans aim to affect individual's mobility behaviour with different policy measures. Nowadays the idea of most transport system planning is to steer mobility behaviour towards more sustainable and active modes of transport, e.g. walking, cycling, and public transport. Without considering the different perspectives of mobility behaviour, it is difficult to understand the logic of behaviour change. Travel should not be seen as simply 'getting from A to B' but rather as a multidimensional, sophisticated concept that requires a more comprehensive analytical framework than the conventional

economic perspective paradigm (Te Brömmelstroet et al n.d.). It is important to consider all the perspectives of mobility behaviour in order to comprehensively understand the different aspects of moving around. Without considering mobility behaviour's different perspectives, it is hard to understand transport systems comprehensively.

2.1.2 Social impacts of transport

The social impacts of transportation have been vaguely conceptualized and hard to define since the current knowledge is fragmented across a large number of different disciplines including spatial planning, human geography, social policy, sociology, public health, engineering, and transportation; each one with its own dominant approach and methodology (Markovich and Lucas 2011). Jones and Lucas (2012) note that the social dimension of transport focuses on people, their attitudes, behaviour and well-being. This view highlights transport's social and psychological aspects. The concept of social impacts does not have a universal definition neither in practice nor in academic papers. Nor are there any widely accepted methods for assessing the impacts.

On top of the lack of universal definition and methodology, the social impacts of transport can be hard to distinguish from the economic and environmental impacts of transport. I can be difficult to define whether, for example, a traffic safety issue has economic or social impacts. It could be beneficial to first understand the implications of transport, and then recognize that each potentially has an economic, environmental, and a social dimension (Jones and Lucas 2012). Therefore, one transport impact might have all three dimensions included in it. This might lead to the issue of double counting; however, it is more important to realize that an impact might have more dimensions to it rather than to claim an impact as being solely under one dimension. (ibid.) Geurs et al. (2009) have discussed that a distinction needs to be made between an economic impact and an assessment of impacts in monetary terms. An impact can be both social or environmental and be expressed in monetary units at the same time (ibid).

Geurs et al. (2009) have offered perhaps the most quoted definition of social impacts of transport. They state that social impacts of transport are "changes in transport sources that might positively or negatively influence the preferences, well-being, behaviour or perception of individuals, groups, social categories and society in general". The definition is wide in order to enable the consideration of also economic and environmental impacts which might have a social dimension. (ibid.) The definition is almost too wide since it enables considering all the possible changes in transport sources which might have positive and negative influences. A more focused definition would serve the interest of developing the field into a more coherent form which would be easier to grasp. However, in the interest of exploring all the views and possible social impacts, we shall stick to this wide definition in this report.

Geurs et al. (2009) have also provided an explanation (figure 5) of how transport policy interventions, be it either an infrastructure project or a policy implementation, have different impacts on various individuals and groups of individuals. The idea is that transport policy intervention creates a source that leads to physical effects. For example, a transport system plan has stated the building of a new tram line which then leads to the construction of the line. These effects may have social dimensions if they change preferences, well-being, behaviour and perceptions of the individuals, e.g. some people may think about changing their travel behaviour due to the improvement in accessibility. Effects turn into impacts when effects exceed the individual's personal sensitivity levels, e.g. when the

individuals change their travel behaviour and start using the tram line as their form of transport. These impacts are then distributed among identifiable groups of individuals. These impacts can be distributed across space, time and social groups. If these impacts cause social differences that are unacceptable according to the values of society, they are labelled as social injustice, and in this concept, transport injustice. (ibid.)

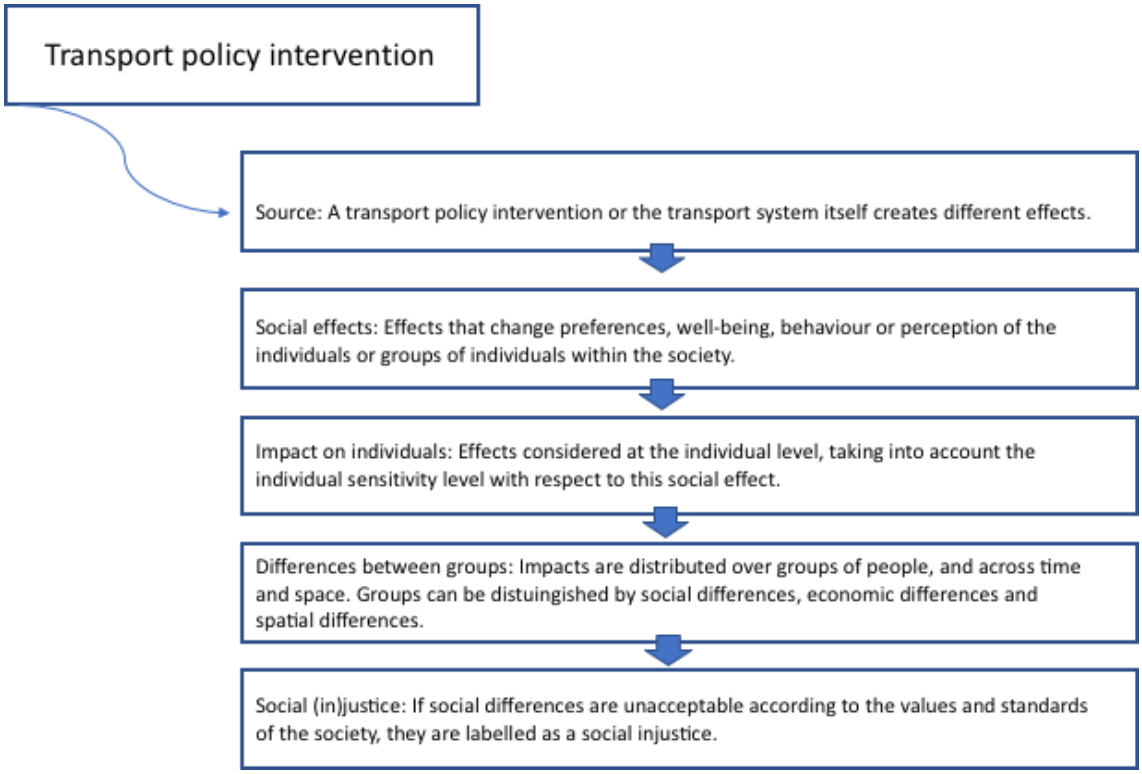

Figure 5. The source-effects-impacts-receptor chain. Source Bueno Cadena 2017 (originally adapted from Geurs et al. 2009).

Academics from multiple disciplines have been examining, categorizing and enlisting the different social impacts of transport (Forckenbrock et al. 2001; Markovich and Lucas 2011; Jones and Lucas 2012). Geurs et al (2009) categorized social impacts under five different subcategories: 1) presence of infrastructure, 2) presence of (parked) vehicles, 3) presence of transport facilities, 4) movement of vehicles, and 5) travel. Jones and Lucas (2012) on the other hand have made a somewhat different categorization of social implications of transport which they have clustered also into five different sub-categories: accessibility, movement and activities, health-related implications, finance-related implications, and community-related implications. On top of that many researchers from different backgrounds have focused their studies on a specific social impact (Schwanen et al. 2015; Litman 2019b; Pyrialakou et al. 2016; Stanley et al. 2012).

The next few pages will examine these previously researched social impacts of transport further which are based on the source-effects-impacts-receptor chain (Geurs et al. 2009). Since this thesis focuses on the system's level, the transport sources are here stated as impacts to enable a feasible level of analysis. If the thesis were to consider the individual level more closely, the study would focus on the impacts the transport sources have on individuals, such as behaviour change, or changes in mental and physical wellbeing.

Accessibility is one of the most essential social impacts of transport. The concept has many definitions. Geurs et al. (2009) have considered accessibility as the presence of transport facilities, services and activities. This view stresses accessibility as physical availability and access to services, as service level and as the spatial distribution of services and activities. In the 21st century, accessibility has also a digital dimension and involves the access to digital services or access to services via digital entry. Affordability is closely connected to accessibility. Affordability concerns the relatively high cost of travel and its affordability to especially people of lower in-come. This has two effects: 1) when trips are made, the relatively high cost reduces money left for other essentials, and 2) when the trips are not afforded, people suffer from social exclusion and a lack of access. (Geurs et al. 2009; Jones and Lucas 2012.)

Lack of accessibility, affordability and movement has been said to create negative social impacts. Lack of access and mobility may cause transport disadvantage which is connected to social exclusion and lack of social capital (Schwanen et al. 2012; Stanley et al. 2012). Preston and Rajé (2007) stated that social exclusion is a constraints-based process which causes individuals or groups not to participate in the normal activities of the society as residents and has important spatial manifestations. Stanley et al. (2012) adopted Putnam's definition of social capital and stat-ed that social capital considers the development of reciprocity, social networks and trust between people. The authors pointed out how the increase in trip making increases person's social capital and is likely to reduce social exclusion. Hence, the more trips, the less the person is prone to suffer from social exclusion. (ibid.) Preston and Rajé (2007) also stated that individual's mobility is connected to social exclusion, hence improving accessibility and affordability of transport are the key ways to ease social exclusion and built social capital. On the other hand, enabling the ease of movement is, however, somewhat contradictory to the targets of reducing vehicle mileage which should be also recognized.

Delbosc (2012) has seen lack of access as essentially being an issue of human well-being. When people have opportunities and possibilities for movement to the essential locations and activities in their lives, such as work, groceries, meeting friends and family, people's overall well-being increases or stays at status quo. When the possibilities for movement are lacking, it creates negative impacts on overall well-being, such as stress with its multiple impacts, social exclusion and lack of social support networks. (Delbosc 2012.)

Jones and Lucas (2012) have enlisted various health-related social impacts of transport which are an effect of mostly road traffic. Traffic safety issues, e.g. road casualties and injuries, is an inter-nationally growing concern. Traffic safety is an issue for individuals who use transportation and for individuals in the vicinity of transportation (Geurs et al. 2019). Injuries and fatalities cause long-term lack of well-being for the individuals who are directly affected and to the individuals who are indirectly affected, such as friends and family. Traffic safety is obviously an issue of economic importance as well, since injuries and fatalities impact the overall economic performance of the society.

Noise pollution and air quality issues are aspects of health-related social impacts of transport. Both are usually categorized under environmental impacts of transport, however, they both have a social dimension to them. Noise pollution is considered nowadays as a significant public health problem with consequences such as sleep deprivation, cognitive impairment, high blood pressure, cardiovascular disease, and heart attacks which all lead to a decrease in overall well-being. The transport policy response has been to

impose maximum noise levels from motor vehicles through EU directives, impose sound barriers on busy streets or reduce speed limits in urban areas. (Jones and Lucas 2012.)

Air quality issues have been the top priority of transport policy due to large amounts of research made of the harmful health effects of various pollutants mostly caused by road traffic (Jones and Lucas 2012). The EU has taken a stand on improving air quality due to harmful pollution levels in many cities through a directive on levels of air quality in cities and directives on maximum emission levels of vehicles. Finland has its own air quality standards which are in line with international standards. (Helsingin kaupunki 2019.) Air quality issues are linked to distributional impacts since there is correlation between transport modes and high emissions. A research done in London showed that emission concentrations tend to be higher or highest on buses, and much lower in individual cars. Since individuals of lower income tend to commute by bus and individuals of higher income tend to commute by car, there are differences in how the harmful emissions distribute socio-demographically. (Rivas et al. 2017.) The results may not be the same in Helsinki region, however, a rule of thumb is that even residents who do not produce local emission (cyclists, pedestrians, public transport users) will be exposed to them.

Active travel is another health-related aspect with mostly positive impacts for people (Jones and Lucas 2012). Active travel consists of walking and cycling and other modes of travel that involve actively using one's own muscles. Active travel has been linked to improved public physical and mental health, user enjoyment, increased community cohesion, more neighbourhood security, and improved traffic security due to possibly reduced automobile travel. On top of that increased active travel also has positive implications on the environment and economy. (Litman 2019b.) A survey study conducted in Finland also links active travel to an increased sense of overall wellbeing (Höysniemi and Salonen 2019.) The promotion of active travel and its positive effects are well known in Helsinki region. MAL 2019 plan has proposed significant funding for the increase of active travel infrastructure and the active travel mode share is continually monitored through travel surveys and traffic counts (HSL 2019).

The intrinsic utility of travel is considered a feature of health – both mental and physical (Jones and Lucas 2012). The mobilities turn in social sciences has found that mobility is endemic and intrinsic to life, society and space (Grieco and Urry 2012). Therefore, travel and movement can also be desired in its own sake (Mokhtarian and Salomon 2001). The idea of intrinsic travel contradicts the standard assumption of travel as a disutility and as derived demand (Diana 2008). Intrinsic travel means that humans do not necessarily travel solely from location A to reach location B; traveling and movement is in itself important to individuals. An example of intrinsic travel is a motorcycle ride done just for the sake of traveling by motorcycle. Lots of intrinsic travel is related to working out, e.g. running and cycling. Intrinsic travel is also recognized in HSL by the form of walking tours; however, it has not been researched further (HSL 2019d).

The design of built environment has its own social impacts. Geurs et al. (2009) state that the mere presence of transport infrastructure may affect the well-being and quality of physical environment. The impacts can be both positive and negative depending on the built infrastructure. The authors also point out how the presence of parked vehicles dominate large areas of open space resulting in affecting especially the visual quality of built environment. The impact here is mostly negative, since large areas occupied with parked cars reduce other street activities and can be a traffic safety issue due to visual obstruction the cars create.

Another issue of built environment relates to barrier effects produced by transport infrastructure (Geurs et al. 2009). Barrier effects may either decrease or increase social interactions of a community, for example, busy highways will most likely create a form of severance, yet it can be decreased by creating good connections under the infrastructure. Barrier effects are in close connection to accessibility since barrier effects may decrease the individual's overall accessibility. If these effects are not carefully planned in neighbourhoods, the accessibility of the whole neighbourhood may decrease.

Travel experience is essentially an implication of travel and transport, and it has a distinctively social dimension. Travel experience has been recently viewed in relation to promoting sustainable modes of transport. The change for a desired behaviour is more likely to occur if the person can link positive emotional responses with the execution of the behaviour (Kahneman and Krueger 2006). Hence, if people have good experiences while using public transport, they are more prone to use it later as well. Travel experience has also been researched from a well-being and travel satisfaction points of views and it is also usually studied in relation to specific modes, e.g. travel experiences of pedestrians (De Vos et al. 2013; De Vos and Witlox 2017; Duman 2018). Travel experience is, however, more than just travel satisfaction or well-being while using certain modes of transport. It is a highly multidimensional and complex concept which considers the complexity of people's travel and their experiences with travel (Duman 2018). Hence, understanding travel experience should consider factors of transport system, transport mode, built environment and land use planning.

The perceived fairness of transport system has been recognized as an important social dimension of transport. A strong relationship between equity and acceptability is generally assumed since the latter may reflect an overall sentiment of fairness towards a transport policy initiative (Bueno Cadena 2017). The perception of equity is an essential element among effectiveness, acceptability and implementation of transport measures (Levinson 2010). Equity considerations become important especially when different transport policies are implemented. For example, different road charging policy initiatives have usually faced frantic opposition, which has been based on the questions of equity. At the same time, with the rising levels of active travel, the distribution of space per mode of transport has also awakened discussions on the equity of space. Perception of equity is in connection to distributional impacts which is discussed in depth in the next section.

The authors also consider the community-related implications of transport. Community in this context is defined as a spatial community of an area, not identity related. One aspect is the perceived safety of transport which in practice means the fear for one's personal safety. This has a significant impact on social interactions and personal mobility. Some impacts are the unwillingness to let children play outside, the unwillingness of traveling in the evening, and fear of accidents. Some groups that are especially affected are women, people of visible minorities, people with disabilities, and people of low income. Another community-related social implication of transport relates to forced residential relocation. Forced relocation happens due to large infra-structure projects, or increased rent prices due to better accessibility. (Jones and Lucas 2012.) This is a more international phenomenon, and not yet a major issue in Finland due to government-controlled rent markets. However, individuals have had to relocate with reasonable compensation due to major transport infrastructure projects, for example, in the case of West Metro.

As it can be seen, the social impacts of transport are a wide field involving different transport phenomena. Figure 6 tries to present all the mentioned social impacts by themes and subthemes. The main themes are presented in green and the subthemes in pink. These presented social im-pacts of transport are derived from multidisciplinary literature. Most of them relate to each other in a profound way, for example the already mentioned barrier effects and accessibility connection. Many of the mentioned impacts are already considered in some ways in Helsinki region's context.

Figure 6. Categorization of social impacts of transport by themes and subthemes.

Some of these impacts are direct and physical, such as the impacts of infrastructure. Some are affective and indirect, such as travel experience, which is caused by travel and can affect individual's emotions and perceptions and create behaviour change. Most of the impacts have both affective and physical dimensions.

Another way to portray the impacts is to consider it from a human centred perspective. On a systems level it is more feasible to consider the abovementioned social impacts of transport to ensure a feasible level of analysis. However, on the individual level it is important to understand also the changes in individuals which these impacts create, such as changes in perceptions, preferences, behaviour, and mental and physical wellbeing. Figure 7 presents the individual level and how the abovementioned social impacts of transport essentially create changes on the individual.

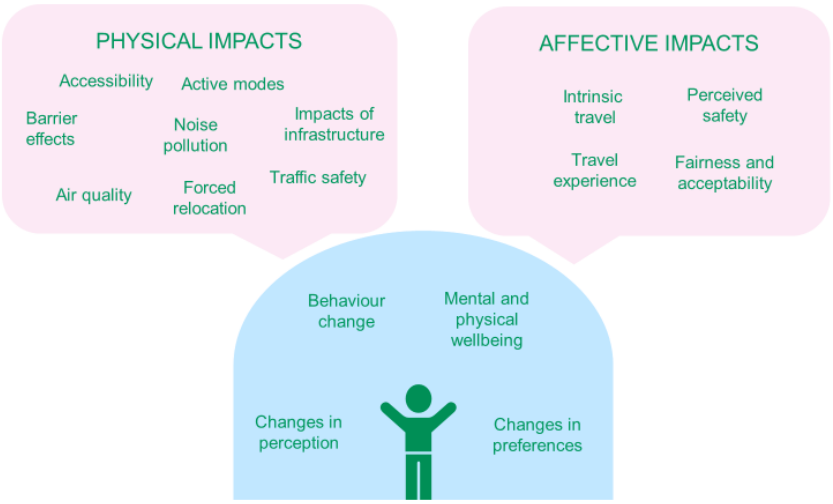

Figure 7. A human centred perspective on the social impacts of transport.

2.1.3 Distributional impacts of transport

On top of the social impacts of transport, a focus on the distribution of transport impacts is highly relevant while assessing transport policies. It is important to know how policy measures affect different areas and different people. Distributional impacts are usually regarded as being closely connected to the social impacts of transport; however, also economic and environmental impacts of transport have distributional effects (figure 8). Distributional impacts show where the impacts of transport policies or transport system plans are situated, at what time, and especially who are the ones affected and how. Assessing distributional impacts is an established part of transport planning practice, especially in relation to planning related impact assessing.

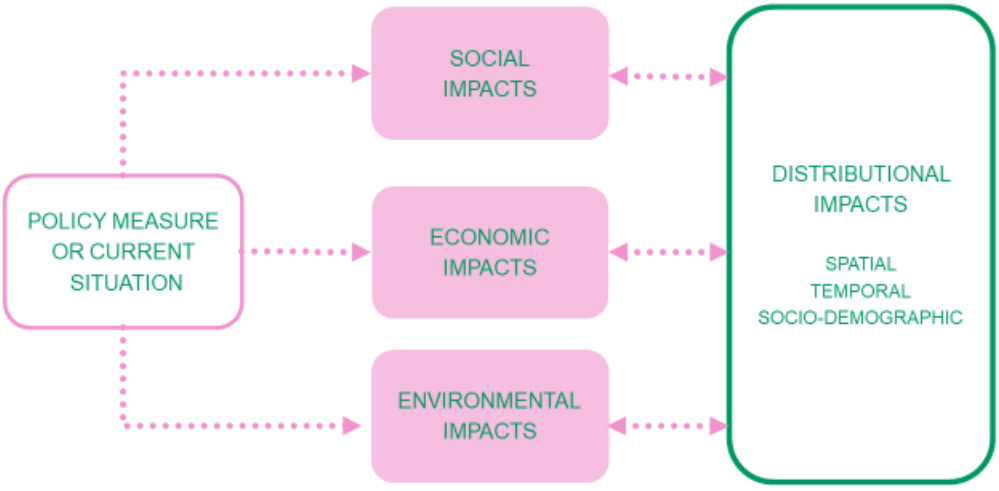

Figure 8. Conceptualization of transportation impacts. Source adapted from Jones and Lucas 2012.

Distributional impacts can take three forms: spatial, temporal, and socio-demographic (Jones and Lucas 2012). Spatial distribution refers to how the impacts distribute on different areas. Temporal assessment considers how the impacts distribute during time of

day or during different months, e.g. at what time will the congestion peak take place. Socio-demographic distribution considers how transport impacts different individuals or groups of individuals. A central aspect of assessing socio-demographic impacts is to understand the differences among individuals since these differences may expose other individuals to endure the costs of transport more than others (Heltimo 2003). Individuals have different abilities to travel, can be more exposed to local pollution, or may endure discrimination in transport. All these aspects affect their mobility and accessibility which should be recognized and assessed when necessary in impact assessing. Some groups of individuals may experience all the distributional impacts at once. For example, an individual of a lower income level may live nearby a busy highway which causes poor air quality and noise pollution during rush hour traffic. The distributive factors in this case are sociodemographic (low-income), spatial (area close to the busy road), and temporal (the impacts are emphasized during rush hour).

The socio-demographic groups which are usually considered while assessing distributional impacts are determined by their travel possibilities and by their sensitivity to transport externalities. Travel possibilities relate to people's ability to travel. The ability to travel can be influenced for a few reasons, however, a central factor relates to the individual's ability to drive or otherwise use a passenger car as a form of transport. Being able to use passenger car relates essentially to individual's age and income level. Income level determines the possibilities and opportunities an individual may possess and affects the travel possibilities an individual may have. High income level enables more possibilities for movement, e.g. more accessibility for the individual, since the alternatives for travel are much broader. High income level enables the use of a car in a situation of otherwise poor accessibility with the help of essentially more income. Individuals of low income have fewer alternatives for travel since the costs of travel may prevent mobility, especially via car, since owning or driving a car is much more expensive than using sustainable modes of transport. This factor is especially highlighted amongst individuals of low income living in remote areas where sustainable modes may be scarce. Hence, accessibility and affordability impacts individuals of low income living remotely the most. Therefore, income level is an essential socio-demographic aspect when assessing impacts of transport. The possibility of using a car is determined also by the age of individual, since children under 18 and the elderly, who are no longer allowed to drive, are unable to drive. This is emphasized in the future with the Helsinki region's ageing population and their possibly decreased travel opportunities. (Jones and Lucas 2012; Geurs et al. 2009; Atkins 2015.)

Since the ability to use a passenger car has distributional effects such as age and income level, it is no wonder that the use of public transport is most common amongst children, elderly, individuals of low income, and women (Heltimo 2003; Markovich and Lucas 2011). It is also noteworthy how gender relates to travel behaviour. Women tend to travel more by walking and by public transport. Passenger car usage is highest on men and on high income individuals, although men tend to cycle more than women. (HSL 2019d.) Therefore, gender determines individuals' travel behaviour in certain ways.

Other aspects related to travel possibilities concern individuals with disabilities, visible minorities, and individuals living in remote locations. Individuals with disabilities face difficulties with travel and tend to rely on accessible public transport for enabling movement, unless they are entitled to social transport services in case of severe disability. Visible minorities tend to fear more in public transport than other groups which can lead to

an aversion of travel behaviour (Masoumi and Fastenmeier 2016). Helsinki region is forecasted to encounter increasing immigration which may change the region's travel patterns if the residents obtain different travel behaviour. Also, as stated before, individuals living in remote locations tend to have less travel possibilities than individuals living in high density areas since public transport services lack effectiveness in remote locations.

Sensitivity to transport externalities relates to sensitivity to local emissions and noise pollution caused by mostly road traffic since these emissions are produced in the street space of cities. The most central local emissions produced by road traffic are particles (PM10 and PM2.5), and nitrogen dioxide (NO2) (Amundsen and Sundvor 2018). These local emissions are most harmful for children, elderly, and people with respiratory or coronary artery deceases. Noise pollution is mainly caused by road traffic, although air traffic is a major cause of noise pollution in parts of Helsinki region. (Helsingin kaupunki 2019.) Noise pollution causes cognitive impediments, sleep deprivation, and a subconscious stress reaction. Noise pollution is especially harmful for children but can be seen an issue for other groups of individuals who may not have the same possibilities for relocating or changing their surroundings such as elderly and otherwise disadvantaged individuals (Markovich and Lucas 2011). Traffic accidents and fatalities distribute increasingly to young and old. Elderly are much more in risk of dying in pedestrian accidents than any other group. The sensitive groups in relation to traffic safety are people whose ability to move and function independently is undeveloped or weakened due to illness, disability, age or other reasons.

When assessing socio-demographic distribution of impacts, one should also consider how transport impacts the vulnerable and quiet groups. The quiet and vulnerable groups are usually discussed when wanting to highlight the more vulnerable status, special needs, and exposure to different costs of some groups of individuals (Heltimo 2003). The quiet groups are usually referred to when wanting to recognize the groups of people whose opinions and views are not heard since they do not reply to survey studies or do not participate in society or planning in other ways. Vulnerability is a term to demonstrate and analyse which people are most affected by external factors, such as busy roads, transport infrastructure projects, or policy measures (Bűttner et al. 2018). Vulnerability is the degree to which a system, or in this case an individual, is likely to experience harm due to exposure to a hazard, e.g. local pollution (Turner et al. 2003). Vulnerability to stresses or shocks has been characterized with three dimensions: exposure, sensitivity, and resilience. Exposure refers to the dose of stress, sensitivity refers to the capacity to absorb the stress, and resilience refers to the ability to adapt and reduce the impact of the stress. (Kas-person et al. 2006.) Socio-demographic groups that are sometimes referred to as vulnerable in transport system planning are people of low income, children and elderly, visible minorities, people with physical or mental disabilities, people who are either too old or young to use cars, and people who do not have a car to use (Tiikkaja et al. 2018; Heltimo 2003).

Currently the temporal and spatial impacts tend to be considered more in ex ante impact assessments than the socio-demographic impacts. For example, while assessing a proposal of a high-way extension, the planners usually study scenarios, such as where are the parts of the highway are congested currently, in the future, and when do the peaks occur during the day. These distributional factors are also studied in MAL 2019 planning and its impact assessing in various analyses. However, the distribution of sociodemographic impacts is hardly ever studied despite transport policies often having significant impacts on people according to their age, income-level, gender, disability, and minority status

(Bueno Cadena 2017). Since the distribution of impacts touches the subject of who gets what, it is closely related to the ideas of fairness and justice, although studying distributional impacts is not essentially normative.

When the distributional factors studied are socio-demographic, one analysis method that has recently gained momentum has been the equity analysis where the focus is on assessing the equity of the distribution of costs and benefits. For example, which are the socio-demographic groups that benefit from a highway extension and who will not. Despite the widespread implementation of transport policies in cities and regions, there is still only a limited evaluation of the equity impacts of policies in transport system planning practice (Bueno Cadena 2017). Studying socio-demographic distribution of impacts in MAL 2019 planning process does not yet consider equity aspects.

For the sustainable future of city regions and transport systems, it is essential that planning con-siders and understands the aspects of the distribution of costs and benefits also from a socio-demographic viewpoint. Since the perceived fairness of planning is considered essential for implementation and acceptability of planning initiatives, the fairness and equity of transport systems is important to consider. Hence, we shall next look into the different aspects of transport justice, equity, and equality in order to understand and consider these factors in transport system planning.

2.1.4 Utilitarian and distributive frameworks

Many aspects of public discussion on transport system planning are essentially connected to the ideas of what is a just city and how do we build cities and transport systems in a way that is just and fair for all residents (Fainstein 2009). One could argue that discussions on how the city dis-tributes public space or plans transport systems for all modes of transport are moral questions in the end. Justice in transport has often been related to the fairness of physical distribution of goods and services, accessibility of people, affordability of services, and distribution of other gains e.g. increases in land prices (Beyazit 2011). In this respect the practice of transport system planning must deal with questions of justice all the time, whether that is understood or not.

Transport planning research and practice tends to focus on utilitarian and distributive theories of justice whose background lies in the moral philosophical theories of social sciences. Utilitarianism is perhaps most widely circulated and utilized viewpoints in transport planning practice. The main idea of utilitarianism is maximizing utility for maximal amount of people. In its purest form utilitarianism does not differentiate utility on moral grounds. (Martens 2017.) Utilitarianism has been incorporated into transport planning practice and can be seen, for example, in the utilization of cost benefit analysis which focuses on analysing the aggregation of utility - the net benefits. The aim is that the aggregated benefits and costs are distributed equally, in a manner that benefits everyone the same extent (Ecola et al. 2019).

Utilitarianism has been critiqued for multiple issues. The main issue with utilitarianism is that it does not consider the distribution of utility, just the aggregation of utility (Beyazit 2011). This has led to the neoliberal market-based demand assessments of transport which does not consider all the possible needs nor wants of the individual since the distributional effects are not considered. (Gössling 2016; Beyazit 2011.) Another issue, related to the previously mentioned, is that utilitarianism has an assumption that humans are essentially

rational, “homo economicus”. This has led to consider that people are essentially rational decisionmakers maximizing their own utility (Martens 2006).

The distributive frameworks, however, see justice as centrally related to the idea of fairness and what is fair allocation. The distributive frameworks were originally formed as a response to utilitarianism. The fair allocation is usually defined as equity in the distributive frameworks which in the transport sector is called transport equity or transport justice. Three components of equity in transport have been distinguished: 1) the benefits and costs that are being distributed, 2) the population groups over which benefits and costs are distributed, and 3) the distributive principle that determines whether a particular distribution is “morally proper” and “socially acceptable” (Di Cuommo et al. 2017).

The Rawlsian distributive justice theory is currently quite central in society and in transport planning practice. It was originally formed around an idea of “the veil of ignorance” which enables a more just distribution of benefits and leads to a minimum level of benefits for everyone. Rawls’s central thesis is that everyone has the right to universal and equal basic freedoms. When social and economic inequalities exist in the society, they must fulfil two conditions: 1) they are linked to office and status to which everyone enjoy equality of opportunity, 2) the status of the least well-off people must be improved the most which is called the difference principle. (Halmetoja 2012.)

The Rawlsian tradition can be seen also in the transport sector, for example, in the minimum ser-vice levels of public transport which mirror Rawls’ minimum level of benefits idea. However, Rawlsian idea of the difference principle has not yet been essentially incorporated in the transport planning practice. Transport planners do not usually consider that the distribution of transport benefits should be allocated in a way that, for example, would assist the areas of the least accessibility currently the most in the future. This tradition may create issues of transport inequity in cities (Martens et al. 2012; Di Cuommo et al. 2017; Gössling 2016).

Another theory of distributive justice is the capabilities approach. Originally formed by Amartya Sen and Martha Nussbaum in the 1980’s, the approach focuses on human capabilities and the equality of opportunity (Hananel et al. 2016). The capabilities approach includes two key concepts: 1) functions which encompass the goods, services, activities and positions that a person would like to consume, undertake, or be; and 2) capabilities which represent the actual combination of functions that a person can achieve and accomplish. (Sen 1982.) Hence, the capabilities approach reflects the ability of individuals to function or to achieve goals and functions. The key justice criterion is the provision of basic goods and services that are necessary to enable all individuals in a society to enjoy an equal level of freedom, and hence to enable and realize their full potential. The argument is that it is not enough to ask how to allocate or distribute available re-sources; the relevant question is, what can one do with these resources to improve the welfare of individuals, especially the disadvantaged. The key question of the approach is what an individual is able to accomplish if they are given all the necessary capabilities. (Hananel et al. 2016).

The capabilities approach focuses on the individual and thrives to enable the individuals the life they wish to live with the resources of the society. The approach has also focused its efforts on setting a threshold of the minimum required in the spirit of Rawlsian distributive justice. Hence, it focuses on defining a minimum level of utility for everyone,

for example, minimum level of accessibility to all in order to enable everyday life mobility. Contrary to Rawlsian distributive justice, the capabilities approach sees that the minimum level of utility may differ from individual to individual, as Rawlsian approach has a universal focus about the minimum level of utility being the same for all.

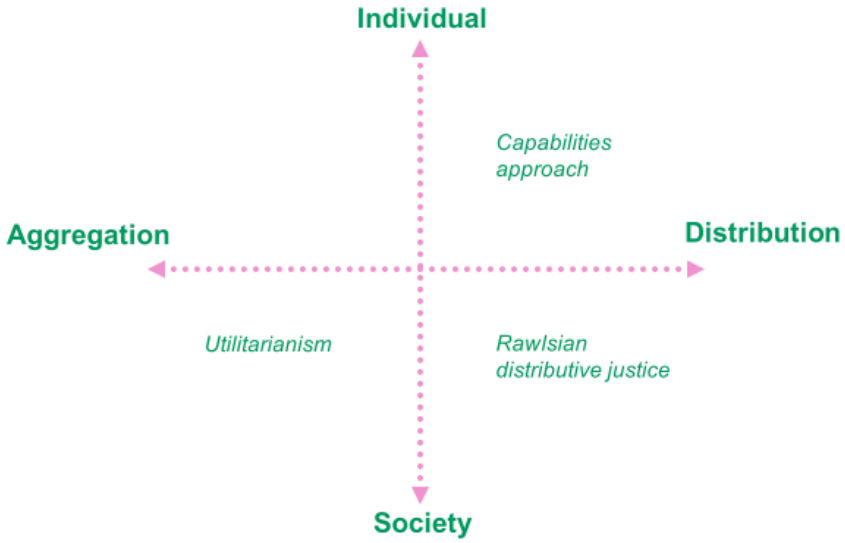

Figure 9. Utilitarianism, Rawlsian distributive justice and the capabilities approach in x and y axis by division of utility and focus on the individual or society.

In conclusion, the discussed distributive justice theories differ on whether they consider the distribution of costs and benefits by aggregation (maximizing utility) or by distribution based on certain values (e.g. the difference principle). The theories also differ on whether they focus more on the society or the individual. Figure 7 presents how the Rawlsian distributive justice and utilitarianism both focus on the society, while the capabilities approach does consider more the individual. On the other hand, the capabilities approach and the Rawlsian distributive justice consider the distribution of utility from a viewpoint where the least well-off should be enabled more, while utilitarianism considers aggregation, hence, just maximizing the utility for maximum amount of people.

2.1.5 Fair distribution and transport justice

The current notion of transport research is that transport systems are unjust. These transport injustices are related to the fact that in most cities transport systems benefit only a share of traffic participants, while putting considerable burdens on others, as well as residents and society as a whole (Lucas 2012; Martens et al. 2012; Gössling 2016). The academic discussion on transport justice centers around transport equity and what is fair allocation of costs and benefits in the transport system. This section presents a few viewpoints on transport justice discussion without taking a normative stance.

Many academics have discussed the different injustices in depth and contemplated the issue by providing examples. Gössling defined transport injustices into three dimensions: exposure to traffic risks and pollutants, distribution of space, and the valuation of time. Here the focus is also on the unequal distribution of the burdens associated with transport choices for other traffic participants, residents, and society. Gössling points out how the burdens of road traffic (accidents, noise pollution, poor air quality, smell, enhancement

of climate change) cause negative environ-mental, social, and economic effects to all residents and society but the benefits of road traffic (time savings, journey satisfaction, traffic priorities) fall mostly only to those who drive their own vehicles. The same goes with his notions on the distribution of space (area use, infrastructure). A large amount of the space in cities is allocated to car infrastructure (roads, parking) while dis-missing infrastructure of cycling and walking. This unequal distribution of costs and benefits of transport systems creates an unjust urban transport system. (Gössling 2016.)

Martens (Martens 2006; Martens 2012; Martens et al. 2012; Martens 2017) has discussed how to analyse equity of transport systems and how to make transport systems more equitable. Martens et al. (2012) defined access or accessibility to be the most important measure of benefits from transportation plans and investments. Transport systems are unequal, since the distribution of access in society is unequal. The availability or unavailability of transport shapes people's life opportunities, considering that it determines whether a person can take advantage of education, use health services, access job markets and thus advance economically. Accessibility should be more important in guiding transportation planning practice since there is a strong relationship between access and people's life opportunities. In this view, accessibility is thought to be the most important measurement of benefits, hence studying the distribution of access can give an insight on how equally the goods are distributed in the transport system according to a predefined definition of equity. (Martens 2012; Martens et al. 2012.)

A set of principles for guiding the distribution of transport investments and services should guarantee that 1) the gap between the areas with the lowest and highest levels of accessibility should remain within a predefined range (space-related equity), 2) the gap between car-owning and car-less households residing in the same area should remain within a predefined range (mode-related equity), 3) while aiming to achieve the highest possible access level across areas and mode-related groups. (Martens et al. 2012.) There is a need to have a predefined range of accessibility between the most well-off areas and the least well-off areas, an accessibility range so to speak. When there exists a predefined range, the transport system planning should focus on the fact that the range doesn't get any wider, and the transport system would then be more equitable. (Martens et al. 2012.) The contrasts between the least well-off and the most well-off areas are not as stark in Helsinki region as in many other areas in the world, and many of the differences in the distribution of accessibility in the region relate to land use decision-making, not necessarily transport system planning. Nevertheless, the predefined accessibility range is an interesting possibility to keep in mind when it comes to possibly setting targets.

Some academics have expressed the need to put the focus on the individual in order to create an equitable transport system. A threshold method has been proposed for transport planning which specifies the minimum required for a person to live a full and free life. They call for a clarification of the extent of mobility and access to opportunities that the transport project provides for various individuals, yet especially the disadvantaged populations. They criticize current transport planning and its consideration of "the average user" which is due to transport modelling that usually focuses on the averages. However, current transport planning that focuses on the average user does not consider populations whose wellbeing is below average since the transport model itself does not do so. (Hananel et al. 2016.)

Since transportation cannot change personal characteristics of individuals in the short term, transport justice concerns tend to focus on improving the accessibility of various

groups on different transportation modes also for pragmatic reasons. For this reason, affordability, accessibility, and personal and group mobility has been considered the most important equity categories. Since the disadvantaged populations and their mobility and accessibility is essential, a method for enabling transport equity starts from identifying these vulnerable population groups. Once the groups are identified, the respective measures include: 1) maximum allowable travel time to various desired destinations for all residents in the area; 2) maximum allowable travel distances to desired destinations, within a specified time frame, for all residents in the area; and 3) maximum allowable travel expenses (fares), by mode, in units of affordability (e.g. percent of disposable income), for all residents in the area. These measures should be assessed as a package, not individually. As stated, this is a threshold method for transport planning which begins with goal-fulfilling needs, and assuming that all individuals have unique rights and needs as stated in the capabilities approach. (Hananel et al. 2016.)

The transport justice literature's unifying factor is that the authors usually propose different policy initiatives in order to create a more just distribution of costs and benefits of transport systems since currently, according to their views and as stated previously, the systems are considered to be unjust. The field also stresses the need for clearly defined equity targets to be followed in the planning practice which would enable the system to steer towards more equal distribution (Martens et al. 2012). Even though this might be true, considering that target setting usually enables policy towards the set direction, the fact is that comprehensive equity targets for transport system planning are very hard to define, and perhaps for that reason they have not yet been widely popular. First and foremost, the target setting is a political process which takes time and effort to conclude. Second, it's hard to define the target and what it entails. Should the targets for example consider the pricing of transport or perhaps also accessibility? Should certain groups of people who might be considered as vulnerable be advanced more than the ones who already have more? And if so, where is the threshold for "having more"? For the targets to be concise and ease with steering the planning, they should focus on a specific aspect of distribution of costs and benefits and not fall victim to the watering comprehensiveness of all-encompassing targets. Accessibility as the possibility for movement has been deemed the most important aspect of equity (Martens 2012; Martens et al. 2012) and could be a possibility while possibly setting targets.

2.1.6 Summary of the social dimension of transport

The social dimension of transport consists of multiple disciplines, methodologies and viewpoints. The essential insight is that social dimension focuses on people, their attitudes, behaviour and well-being (Jones and Lucas 2012). Because of this, the social dimension bases its emphasis upon the on social and psychological perspectives on transport and mobility behaviour. It could be said that the social dimension is just another point of view on transport with slightly different emphasis since, for example, accessibility can be viewed from multiple different perspectives. Main-stream transport system planning's economic perspective considers travel time and travel time savings while investigating increase in accessibility. Environmental perspective considers the accessibility of sustainable transport modes or the increased fluency of traffic in order to de-crease traffic-related emissions. Social perspective on the other hand considers the increase of well-being that improved accessibility would bring communities with increased possibilities for movement. If one perspective on transport is missing, the impact assessment lacks comprehensiveness. In the end, the studying of the social dimension of transport enables a more holistic view on transport.

When assessing the social dimension of transport, one needs to consider the multiple dimensions of mobility behaviour, the social impacts of transport, and the distributional impacts of transport. It is important to note that mobility behaviour constitutes of also psychological and societal processes, not solely of the economic perspective of travel time savings. The social impacts are important to consider, since as stated before, impacts have different dimensions and without considering them all, some will inevitably "fall off the radar". If a dimension is not considered, it will not be assessed either. The same goes with assessing the distributional impacts which need to be assessed from spatial, temporal, and socio-demographic viewpoints. It is important to recognize the dimensions that should be considered in the assessments. Not all temporal dimensions or socio-demographic groups are necessary to assess in each impact assessment. The decision of what to assess in relation to a transport intervention should be considered case-by-case.

When the topic surrounds the distribution of costs and benefits, it can be hard to differentiate the planning and assessing from normative or political views. When it comes to the equity of transport systems and the fair distribution of costs and benefits of transport systems, the current view is that transport systems are unjust, and that transport system planning could improve by establishing certain equity targets for guiding the distribution of costs and benefits (Martens 2006; Martens 2012; Martens et al. 2012; Martens 2017; Gössling 2017; Hananel et al. 2016). The inequity of transport systems is no surprise since transport systems are an aspect of the sur-rounding cities and the surrounding society. So far, no society has been completely equal nor fair; hence it is understandable that the transport systems are not fair either. With this being said, when the distribution of costs and benefits of transport are considered spatially, temporally and socio-demographically, so that decision-makers acquire comprehensive knowledge on the transport system from all the distributive viewpoints, planning may be more equipped to consider also the equity of plans.

2.2 Impact assessment in MAL planning

This section considers the current impact assessment process of MAL planning, the impact assessment methods, and how the social and distributional impacts of transport are currently investigated in the process.

Impact assessment is an important part of MAL planning process. MAL 2019 plan has, when executed, various impacts on the environment and the society. Impact assessment is a way to present those impacts and to support the plan formation and its decision-making. The goal for impact assessing is to increase the plan transparency, to justify plan measures with gathered knowledge, and to support open participation. (HSL 2017.) Impact assessing in MAL planning mirrors the comprehensiveness of MAL 2019 plan which is a much wider entity than any single plan done in the Helsinki region before.

MAL 2019 impact assessment is pervasive as a whole and considers fundamental issues of transport and public policy. MAL planning still occurs on a non-formalized planning level which is situated in transport sector somewhere between societal and transport system planning level, and in land use sector between regional planning and general planning (Mild and Metsäranta 2014). The MAL impact assessment includes elements from transport project appraisals and environ-mental impact assessments (later EIA) and other assessment methods which are all mutually complementary.

The transport project appraisals performed in MAL impact assessments comply with the national transport project appraisal guidelines. An appraisal is mandatory each time a transport project is named in the state budget. Nevertheless, the guidelines work as a standard for project appraisals in communities and in MAL planning. The transport project appraisals are performed while transport projects, e.g. new infrastructure, are planned. The appraisal consists of the description of baseline of the appraised project (which includes defining the alternatives), the description of the impacts, the assessment of the project, the plan for monitoring and ex poste assessment, and reporting and documenting. (Liikennevirasto 2011.)

MAL impact assessment process produces also an EIA. The EIA is mandatory according to the law on environmental assessments of plans and programs SOVA (200/2005) since MAL 2019 plan may have, when executed, impacts on humans, on nature and its diversity, on landscapes, and on natural resources. The definition of environment is considered wide, and the EIA must also consider impacts on humans, for example, on health, on living conditions, and on comfort. (Ympäristöministeriö 2017.)

MAL 2019 impact assessment is an iterative process which is done thoroughly on three different stages of the planning process. The impact assessments consist of core indicators, supporting indicators, and complimentary assessment methods. It also includes an impact assessment ma-trix which portrays a general view on the issues of the Helsinki region, and it is based on MAL 2019 objectives (low-emission, attractive, vibrant, healthy). The matrix demonstrates the focus of the assessment with its different assessment sections which are thought to be affected by the plan. The core indicators reflect the MAL 2019 objectives and are considered the most important indicators. The core indicators are set with target levels for 2030 which steer the planning pro-cess. If a target is not reached, the planning must steer its measures towards reaching the target level. The supporting indicators complement the core indicators and help to understand the causes behind the impacts and the different impact mechanisms. The complimentary assessment methods demonstrate different trends, the differences between plan versions and the impacts of different measures. (HSL 2019b.)

2.2.1 Social impacts of transport in MAL 2019 impact assessment

MAL 2019 impact assessment considers some of the social impacts of transport previously stat-ed in the section 2.1.2. An overlook demonstrates that the assessment considers many of the already discussed social impacts of transport. Further look on MAL 2019 core indicators, supporting indicators, and complementary assessment methods show that the social impacts of transport are considered in MAL impact assessment process for some parts. The full list of the indicators and assessment methods can be found in the MAL 2019 impact assessment report. (HSL 2019b.)

The MAL 2019 impact assessment considers the social impacts quite thoroughly. For example, the core indicators consider accessibility by car and by sustainable modes. The assessment also considers the price of travel while examining workforce accessibility which is linked to the afford-ability aspect of accessibility and the costs of travel. (ibid.)

The supporting indicators that consider social impacts are the following:

- Median generalized trip friction per person trips (K6), which assesses the price of travel and the service level by area.

- Theoretical noise pollution area (H3) which assesses noise pollution based on theoretical noise pollution areas.
- Share of residents exposed to road transport's local emissions (H4) assesses the number of residents which will be exposed to local emissions.
- Amount of transport-related fatalities (H5) which assesses MAL 2019's impacts on transport-related fatalities. (ibid.)

All the supporting indicators are quantitative, and most utilize GIS methods for visualizations. Some are assessed with HELMET model (M11, K6, H5) and some are calculated using other methods (H3, H4). These indicators assess transports impacts on accessibility based on affordability, noise pollution and local emissions, and traffic safety. (ibid.)

In addition, the supplementary assessment methods that consider social impacts of transport are the following:

- Development of safe and healthy living environment (TM10)
- Change in user utility (TM14)
- Externalities (TM16)
- Equal development of travel opportunities (TM21).
- Accessible transport system (TM23)
- Identifying health risks and costs (TM24) and
- Development of safe and healthy living environment (TM25). (ibid.)

The complimentary assessment methods are analysed using various methods: HELMET model (TM16, TM21), GIS methods (TM10, TM24, TM25) and qualitative methods (TM21, TM24). These indicators assess the safety of residents and the environment, the costs and benefits per mode, the costs of transport externalities, and the equity of travel opportunities. (ibid.)

The distributional impacts are analysed partially in the MAL impact assessment. Almost all the indicators and assessment methods deliver a visualization of the impacts on a map, therefore, spatial analysis is widely used. Temporal analysis of distribution is somewhat scarce. Most of the analysis made by HELMET model is done for the morning or evening peak hour traffic in Helsinki region or traffic for the whole day. Since the planning level is regional, the temporal analysis is done according to more general level planning needs. This is understandable considering the planning context, but since the temporal analysis does not consider different time of day or day of week, some of the temporal factors which can be significant are not currently analysed.

The socio-demographic impacts are almost non-existent in the current MAL impact assessing. The complimentary assessment methods TM14 and TM21 consider user aspects (which mode benefits or is inconvenienced by the plan) and the equal development of travel opportunities (con-siders equal development regionally and by mode) respectively. There is currently no assessment of different socio-demographic population groups nor vulnerable groups. When indicators and methods for considering the socio-demographic distribution are lacking, key aspects of transport impacts are not considered.

The MAL 2019 impact assessment program, however, noted that socio-demographic impacts had been studied in the previous planning cycle with the means of traveller stories which were a method for planners to understand the effects on different people and a

method for communication with the residents. The method had since been discarded since it had not been as useful as the planners had hoped. (HSL 2017.) It is encouraging that these aspects have been considered be-fore, albeit not currently since that assessment lacks proper methods.

In conclusion, MAL planning impact assessment process has considered the social impacts of transport even though the term "social impacts" has not been mentioned. Figure 10 presents the impacts which are already studied, impacts which are not assessed at all, and impacts which are assessed partly. The table visualizes the fact that even though the MAL 2019 assessment has not aimed at assessing the social impacts of transport, many of the impacts are somewhat considered already.

Figure 10. The social and distributional impacts assessed in MAL 2019 impact assessment in core indicators, supporting indicators and complimentary assessment methods.

On top of the actual indicators, during the MAL planning process an extra assessment was carried out about the future rapid tram lines in Helsinki, Espoo, and Vantaa. The aim was to compare the future projects and to decide the phasing of the rapid tram projects based on the comparison. One of the methods for the comparison was to assess which rapid tram line would benefit areas the most, and which rapid tram line area currently has the most vulnerable residents residing in it. Vulnerability here was defined by income level and employment status. The assessment showed that the areas of the rapid tram lines of Vantaa and Malmi-Viikki currently have the most vulnerable residents residing in them. (HSL 2018.) This type of assessment is the only quantitative assessment done in MAL 2019 planning process, and it shows that the socio-demographic distribution can be assessed.

2.3 Organizational learning

Helsinki region's MAL planning is a cyclical process as many transport system planning processes are (Te Brömmelstroet and Bertolini 2008). As such the MAL planning process is a good example of organizational learning process since each planning round deepens the knowledge about planning content while also deepening the understanding on the

planning process itself. This thesis is a part of impact assessment development process which essentially is a process in which HSL gathers knowledge from various sources, assesses it, observes it, tests it, and essentially designs an improved approach for impact assessing. Hence, the impact assessment development process is a process of organizational learning, more specifically an example of organizational learning through experience which is called experiential learning. For the impact assessment development process to go forward, the thesis process also has to include aspects of organizational learning to enforce the experiential learning in the MAL process.

Organizational learning considers the learning processes of organizations and answers to the question "how does an organization learn" (Tsang 1997). The topic involves the concept of organizational knowledge. Organizational knowledge is essential to organizational learning since knowledge is the basis for learning. Te Brömmelstroet and Bertolini (2010) made a distinction between explicit and tacit knowledge based on the writings of Polanyi (1967). Explicit types of knowledge are formal (data, formulas) and are therefore easily codified with wide validity. An ex-ample of explicit knowledge in MAL planning process would be calculations produced by Helsinki region's mathematical transport model HELMET. Tacit knowledge on the other hand refers to the knowledge of the individual that he/she has gathered through individual experiences. Hence, tacit knowledge is personal and hard to formalize, which makes it difficult to communicate and share with others. Tacit knowledge is said to play an important role in formal decision-making and should be recognized in the planning process. (Te Brömmelstroet and Bertolini 2010.)

Nonaka and Takeuchi (1995) have described knowledge generation as a social process. Creating relevant knowledge requires linking both explicit and tacit knowledge. The authors conceptualized four modes of knowledge conversion which are represented in figure 11 (ibid):

- Socialization (tacit with tacit): sharing experiences to create new tacit knowledge, observing other participants, and brainstorming;
- Externalization (tacit with explicit): articulating tacit knowledge explicitly, writing it down, creating metaphors, indicators and models;
- Combination (explicit with explicit): considering explicit knowledge by sorting, adding, combining, looking to best practices; and,
- Internalization (explicit with tacit): learning by doing, developing shared mental models, goal-based training.

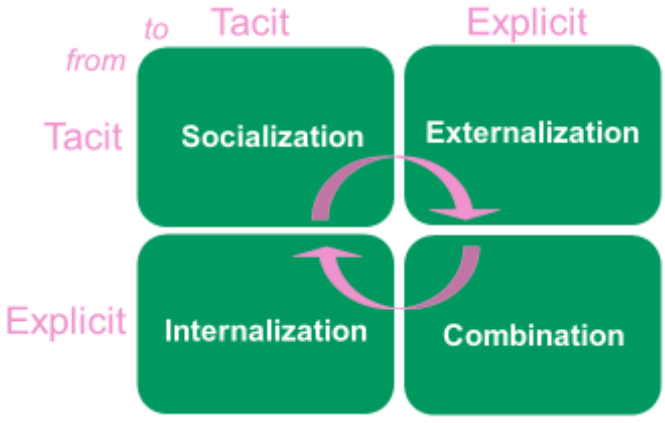

Figure 11. Knowledge generation matrix. Source Te Brömmelstroet and Bertolini 2010 (originally from Nonaka and Takeuchi 1995).

Organizational knowledge consists of knowledge acquisition, knowledge management, information interpretation, and organizational memory (Huber 1991). Knowledge acquisition is essential for any organization. In the context of this impact assessment development process, the essential concept of knowledge acquisition is experiential learning. Experiential learning means that organizations learn by experience either intentionally or unintentionally (ibid). The relationship between knowledge and experience is essential in planning practice. Experiential learning unfolds through an iterative sequence of interlinked activities with a continuous shift between reflection and action. In this learning cycle the observation and reflection on concrete experience leads to forming of abstract concepts, which are then tested in new situations, eventually resulting in the adaptation of practices (figure 12). The process of experiential learning is considered a key aspect in the methodology of this study which is considered closely in section 3.1.

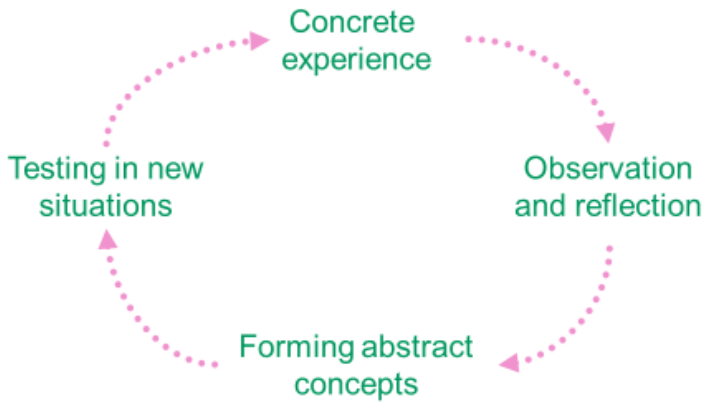

Figure 12. Experiential learning cycle. Source Straatemeier et al. 2010.

Knowledge management is an essential part of enabling organizational learning. Knowledge management considers how the knowledge of the organization could be utilized effectively in the organization. (Easterby-Smith and Lyles 2011, 3). Organizations do not always know what they know. If there are more sources to a specific set of knowledge, the distribution of the knowledge is wider and so more individuals in the organization will most likely learn it. The distribution of this knowledge leads to more broad organizational learning. (Huber 1991.) Knowledge management's main objective is to gather the explicit and tacit knowledge base of the organization to work as the organization's main strategic resource and to support its decision-making (Rajala 2019). MAL planning context produces and acquires an enormous amount of knowledge. The planning and the impact assessment process might not always have a clear view of all the information it consists of since the amount of research and analysis that is being produced is abundant. Hence, knowledge management is essential.

Organizational learning requires information interpretation. Organizations learn when the organization changes its working processes due to the processing of the gathered information. The more the organization interprets the gathered information, the more the organization learns. (Huber 1991.) For example, the three rounds of impact assessments during the MAL 2019 planning process ensured that the process interpreted the gathered knowledge and made changes to the plan accordingly. This cyclical knowledge interpretation process enabled an improved plan.

Organizational memory refers to organization's information restoration. Organizational memory is a critical factor for organizational learning for two reasons. First, the information gathered must be restored for it to be utilized later. Second, the other aspects of organizational learning depend on organizational memory. The knowledge and information which is embedded in the organizational memory steers the process of new knowledge acquisition and the beginning of new organizational learning processes. (Huber 1991.)

Impact assessment process in MAL planning context provides the planning an organizational learning process itself. Learning starts with the individual, but individual learning does not necessarily result in organizational learning (Wang and Ahmed 2003). Organizational learning process requires the interaction between individuals. Knowledge acquisition, interpretation and management have always been a central part of impact assessment process. The impact assessment in MAL planning is participated by experts from HSL, the regional municipalities and the state, consultants and other stakeholders, who can learn during the process when the process itself enables knowledge management, information interpretation, and enhancement of organizational memory. (Sanchez and Mitchell 2017.) The MAL impact assessment's cyclical process enabled communication and dialogue among participants, it made possible the interactive learning during the process, and it has enabled the ex post assessment of the process itself (HSL 2019b).

3 Methodology

In the next sections, I will present the methodology which bases on change-oriented research design science approach which bases on experiential learning. Since this thesis is part of an impact assessment organizational learning process, the methodology of the thesis should consider the aspects of organizational learning in practice. Hence, the methods of the thesis include a regional workshop in order to gain insight from the regional experts, and a case analysis which demonstrates the assessment of social and distributional impacts of transport.

Planning's purpose is to create change in the future. While attempting to design future cities and transport systems, planners are creating change. Research in planning is a part of creating change and as such relates to other design sciences that are all primarily concerned with how to affect their objects of study (Straatemeier et al. 2010). Since this research is a part of an impact assessment development process and as such is rooted in planning practice, the thesis utilizes the change-oriented research design science approach as the basis for its methodology.

Change-oriented research design science seeks to both comprehend a phenomenon and to develop and test a solution (Van Aken 2004). This differs from explanatory sciences whose core mission is to describe and explain observable phenomena within their field. The focus of design sciences is on the other hand on developing knowledge for the design and realization of by-products. A typical product of design sciences is a solution to a problem that is tested in practice and based on scientific knowledge. (Straatemeier et al. 2010). Hence, the premise of the approach is very close to planning practice itself.

The foundation of the change-oriented research design science approach is in experiential learning which is closely related to organizational learning discussed in section 2.3. The concept of experiential learning cycle provides a base for doing academic research and contributing to planning practice at the same time. Straatemeier et al. (2010) used the concept of experiential learning cycle to form a method of experiential research design in which planning and research form an iterative process, each benefiting the other (figure 13). The idea is that planning research feeds *abstract concepts* to the experiential learning cycle while planning practice feeds it *concrete experience*. Practice and research meet in the middle to consider *testing abstract concepts in new situations* and *observing and reflecting*. After observing and reflecting, planning research ponders and iterates and begins to form new abstract concepts which are then fed to the cycle. (Straatemeier et al. 2010.)

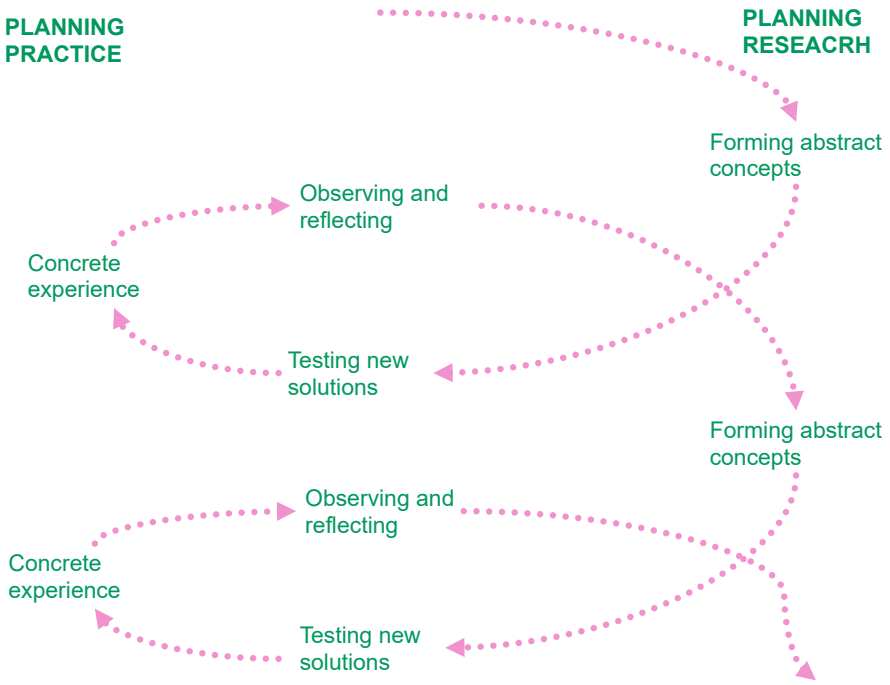

Figure 13. Experiential learning cycle process. Source Straatemeier et al. (2010).

This thesis uses the same cycle process, although modified. In this thesis *forming abstract concepts* refers to the theoretical knowledge gained from the background section of the thesis which feeds its input to the regional workshop as an input material. The workshop works as *testing new solutions*, since the abstract concepts are discussed and, in that sense, tested. The workshop was chosen as a method to a) gain insight from the regional experts, 2) to distribute knowledge to the experts, and 3) to form a mutual understanding on the phenomena. The insight of the workshop and the input gained from MAL 2019 impact assessment material provides the *concrete planning experience* for the cycle as does the input that is constantly gained from the steering group at HSL during the thesis process. The insight gained from the workshop and the impact assessment material is then *observed and reflected* and used to design social and distributional impact assessment matrices. The case analysis uses a similar cycle process and utilizes insights gained from workshop, HSL, and the previous MAL 2019 impact assessment material.

3.1 The design of the impact assessment framework

The thesis is set to design an impact assessment matrix for the social and distributional impacts of transport. An integrated MAL planning practice is a social process in which actors from different backgrounds use explicit knowledge but also their own earlier experiences (Te Brömmelstroet and Bertolini 2010). Much of the MAL planning practice uses communicative planning support in order to facilitate communication among the involved stakeholders (Pelzer 2017). This is usually done with the help of regional workshops which enable knowledge generation and the combining of explicit and tacit knowledge (Te Brömmelstroet and Bertolini 2010). Therefore, at the very beginning of the thesis project, during the first steering group meeting at HSL, it was decided that a

regional workshop should be held for the experts of HSL and the experts of the 14 municipalities of the region in order to integrate the regional views to the thesis and to the whole impact assessment development project.

The workshop serves four purposes. First, it is important to gather the tacit knowledge from the regional experts about the social and distributional implications of transport in the Helsinki region (Te Brömmelstroet and Bertolini 2008). The idea is to explore and brainstorm current regional problems and their possible solutions together (Pelzer 2017). Second, it is essential to inform the experts about the ongoing impact assessment development process so that everyone in the MAL planning process are informed about what is taking place in each part of the cyclical planning process. Third, it is necessary to include the experts in the project since MAL planning is done as an inclusive process and in close co-operation with land use, housing, and transport planners from different organizations, cities and communities. The thesis would not gain all the necessary knowledge if the experts were not included in the thesis project, and it would contradict the premise of inclusiveness the MAL process is based on. The fourth purpose was to gather comments in order to decide which focus the case study should take in order to demonstrate the method to study the social and distributional impacts in the future planning cycles.

3.1.1 Regional workshop

The invitation to the workshop was distributed to a large group of regional experts, and specifically to the experts that were closely involved with impact assessing during the MAL 2019 planning process. The workshop was held on the 23rd of October at HSL premises. There were 14 participants (including the organizers) from HSL's transport system planning group, Espoo, Vantaa, Järvenpää, KUUMA-region, the Centre for Economic Development, Transport and the Environment for Uusimaa, and the Regional Council of Uusimaa. Additionally, since all the interested members of HSL's transport system planning group were not able to join the workshop, another, more agile meeting was held in order to include their views in the project. The meeting was held on 28th of October and included seven participants. The participants were from HSL's transport system planning group and transport research group. Both occasions and their comments are considered in the coverage and analysis that follows.

The workshop started with brief welcoming words from the head of HSL's transport system planning group. Afterwards, the main findings of the background section were presented. After the presentation, the participants were divided into three groups. The groups were not chosen in advance. Each group had a facilitator who was in charge of leading and taking notes of the conversation. The participants were encouraged to write each comment on post-its. Each group discussed the same topics during the workshop and after each workshop session, the groups did a shared wrap-up in which each group presented their main discussion. The workshop was divided into two 40-minute sessions with a 10-minute shared wrap-up after each session. A coffee break was held in between the two sessions.

The set-up for the workshop was chosen for two reasons. First, the set-up was already familiar for many of the participants since MAL planning process utilizes similar workshops while the planning cycle is ongoing. It was important that the participants could focus on learning and discussing their views with each other without being distracted about the structure of the workshop itself. Second, the workshop was structured so that it would best encourage the participants to discuss the subject from their own personal

knowledge base since an integrated planning practice requires platforms to generate common knowledge grounds through socialization (Te Brömmelstroet and Bertolini 2010). This meant a trade-off between encouraging conversation and recording of what was said. It can be hard to record everything solely by taking notes, so a possibility of recording the conversations via voice recorder was discussed. However, it was decided that recording the conversations via voice recorder would disturb discussion since it is not a common practice and participants could get nervous about the recorder which could lead to filtering the conversation. Plus, the participants were not informed by the recording at first hand and it was thought that people should have known about the recording before agreeing to participate. It was understood that trading-off the recording to hopefully abundant and versatile conversations would mean that some of the conversation and the continuum of the conversation would be lost in the note taking.

The first session included brainstorming and interactively learning about the social and distributional impacts of transport and discussing the topic from Helsinki region's context. The questions started off with *"what ideas did the presentation stir up"* and *"what are the most important aspects of social and distributional impacts in Helsinki region's context"*. The second part addressed the steering of the study project. The aim was to discuss the aspects that are currently analyzed in the MAL impact assessment process and plan what should be studied later while the social and distributional impacts of transport are considered in future planning cycles. The questions were *"what social and distributional impacts of transport are already studied enough"* and *"what would be the most useful analysis of social and distributional impacts of transport for MAL planning in the future"*.

The material received from the workshop included post-its and the notes recorded by the facilitators. There were approximately eight pages of typed notes and 20 post-it notes from the participants. The notes were not as accurate as a voice recorder would have been, however, this was known and accepted beforehand. The notes were read through multiple times. The post-its were recorded and included in the notes in the end. The meeting held at HSL to the transport system planners and transport researchers and discussion that followed was included in the workshop notes. In addition, some notes on the subject were handed in after the workshop from regional experts that were not able to participate. Their viewpoints are included in the workshop material.

3.1.2 Thematic analysis

The material gained from the workshop will be examined with the help of thematic content analysis. Thematic content analysis is a qualitative analysis method which focuses on the content of the text – either spoken or written. Thematic analysis considers the similarities and the differences of the analyzed material and aims to simplify the material to enable the analysis. Hence, thematic analysis enables the analysis of large text materials. It is usually used as a first method to analyze the research material. (Hiltunen n.d.)

In this research, it is used to organize the notes gained from the workshop and the meeting at HSL into themes. The focus is to provide a way to organize the information and to facilitate the further analysis. First, the thematic organization will be based on the workshop questions and the discussion related to that specific question. This preliminary organization facilitates the further analysis. Second, the material will be examined further and organized once more based on discovered underlying themes: content-related and

methodology-related. These themes were not decided beforehand but were discovered and observed from the material as two underlying themes of the discussions that took place.

In conclusion, thematic analysis is used to enable the design of the matrix of the social impacts of transport. The analysis helps to organize the material gained so that it can be used to plan the focus of the assessment of the social impacts of transport. The analysis does not in itself lead to answering any research questions, but it structures the material so that the design matrix can be created. While being part of the design process, the analysis works as a way to *observe and reflect*

the input that was gained from the regional experts in the workshop, and hence promotes the experiential learning cycle of the impact assessment development project (Straatemeier et al. 2010).

3.2 Case study

The case study of the thesis demonstrates how the social and distributional impacts of transport could be analyzed in the future MAL planning process. In other words, the case involves demonstrating the use of a planning support system (PSS) in the assessment of social and distributional impacts of transport. For this case analysis to be practical for the MAL planning process in the future, it must be easy to repeat, understandable, and something that gives a new outlook on the Helsinki region's transport system. Easy to repeat because planning resources are scarce, and the most beneficial planning support is something that can be done with resources that MAL planning already has or is easily acquired. Understandable because the analysis produced will have to be comprehensible to experts and decision-makers from very different backgrounds. A new outlook is essential, since MAL planning impact assessment process already produces enormous amounts of information and there's no need for analysis with zero new insight.

Pelzer (2017) has discussed planning support systems and their usefulness. Planning support systems are digital instruments to support planning which are currently widely used in planning practice. The usefulness off PSS can relate to e.g. communication (sharing knowledge amongst stakeholders), learning (gaining insight into the nature of planning object), and better-informed plans or decisions (a decision is based on better information). Usefulness is essentially an outcome of utility and usability. Utility in PSS considers a task-technology fit. The basic premise of the concept is that utility can be achieved if the technology used is suited to the planning task. Technology refers to the capability of the PSS to support the planning tasks. Support can be communicative and/or analytical. Analytical support refers to the capability of the PSS to improve the understanding of the planning issue, for example with performing impact analysis or scenario testing. Communicative support refers to capabilities of the PSS to facilitate communication among the involved stakeholders, since planning tasks are collaborative processes. In addition, usability is about how well users can use the PSS functionality. (ibid.) In other words, if planners cannot use PSS, it is no use for anyone.

Based on these premises and the feedback gained from the regional workshop, it was decided that the case study would focus on analyzing the change in accessibility of sus-

tainable modes of transport and the change in trip friction by public transport. The analysis also studies how the accessibility and trip friction changes distribute on socio-demographic groups, specifically the individuals of low-income level. The analysis is done by Helsinki region's transport model HELMET, geographical information systems and statistics. In this case analysis, the usefulness of the method is defined on how well HELMET model and GIS can help assess the change in accessibility and how the changes distribute on different income level individuals.

The set-up of the analysis was chosen for a few reasons. First, the decision about the focus of the case was made after the workshop with the help of the workshop input, and the insights gained from the previous assessment done in MAL 2019 plan. The workshop discussed the need to assess the socio-demographic distribution of impacts, especially on vulnerable groups. Reading what was previously assessed in MAL 2019 impact assessment process revealed that the assessment lacked the analysis of the impact distribution based on socio-demographics. Hence, the assessment of socio-demographic distribution was selected as part of the analysis. Second, the decision to analyze accessibility was decided since it's relatively efficiently done with HELMET model (and by the time the case was decided on, time was scarce), and most importantly, because accessibility has been seen as an important determinant of how equally the benefits of transport system distribute (Martens 2017).

The focus of the assessment of socio-demographic distribution was decided based on a vulnerability aspect. As stated before, accessibility relates to affordability of travel and the possibility of movement. The possibility of movement is obviously hindered by the lack of affordability. There is a possibility that individuals of low income may have less accessibility than individuals of higher income level. (Jones and Lucas 2012.) Therefore, it was decided that the case would analyze solely the change in accessibility of sustainable modes of transport and trip friction by public transport since sustainable modes of transport enable travel to almost everyone. Second, income level was chosen as the variable of socio-demographic distribution for its relation to accessibility and affordability. It is important to note that low income level does not in itself mean that a person is vulnerable, but low income level has been seen to relate to the accumulation of many issues, such as health issues, lower life expectancy, and social exclusion. (Vesanen 2015; Schwanen et al. 2012). However, in this research the focus is on how lack of money may relate to lack of access, not on any other social issue, e.g. social exclusion.

3.2.1 The methods and data of the case study

The analysis follows loosely the transport project appraisal guidelines provided by the Finnish Transport Infrastructure Agency which is the standard followed also in MAL impact assessing. The steps of the analysis are the description of the project (the MAL 2019 plan), defining the alternative, performing the transport model forecast of the plan impacts, recognizing the impacts, and analyzing the results. It should be noted however that since the case analysis is only a part of the thesis and the focus of the thesis is much wider, the analysis is not as comprehensive and thorough as an analysis would otherwise be.

The assessment focuses on the MAL 2019 plan and its impacts on Helsinki region's accessibility, more specifically the change in accessibility and trip friction. The analysis also includes the distribution of accessibility and trip friction changes on different income levels. The comparison is done by comparing the alternative to the MAL 2019 plan. The

MAL 2019 plan consists of a land use forecast, the base line transport network, the forecasted transport network for 2030, the prospective transport infrastructure projects etc. The plan version had been already set-up in HELMET model and this set-up was used in the analysis without alterations.

The alternative was taken from the previously defined MAL 2019 impact assessment process's alternatives and then slightly altered. Since the idea is to demonstrate a way to include the assessment of socio-demographic distribution of social impacts of transport into MAL planning, it was decided that the alternative should be already commonly known to the regional experts from the previous MAL 2019 plan. It was recognized that changing the alternative too much now could confuse the experts and steer the focus away from what the demonstration is supposed to be doing: to demonstrate how the distribution of impacts on socio-demographic groups could be assessed.

Only slight changes to the alternative were made. The alternative in MAL planning includes the regional land use baseline and the baseline transport network among other assumptions explained. Since the thesis considers the social impacts of *transport*, the land use forecast was excluded from the analysis so that both the alternative and the MAL 2019 plan have the same land use forecast for 2030 in order to show the impacts the *transport system changes* will create in the region. The comparison – the alternative and the plan – are explained in figure 14.

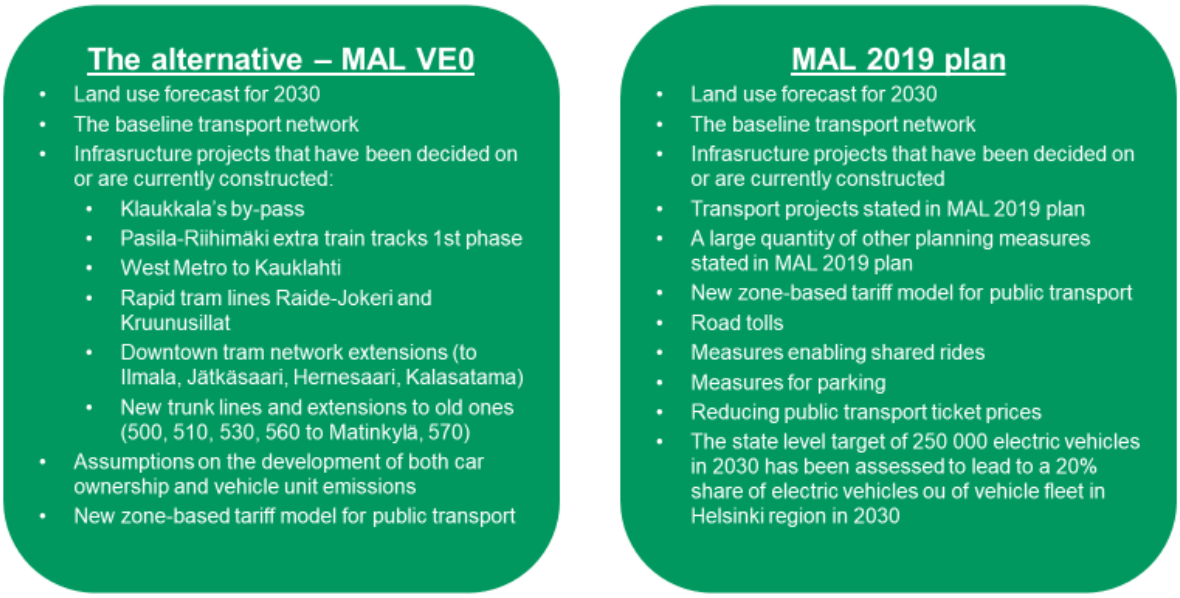

Figure 14. The case analysis comparison including the alternative and the MAL 2019 plan. The transport projects mentioned in MAL 2019 plan are introduced thoroughly in annex 1.

The initial idea after interpreting the insights gained from the workshop was to analyse the changes in accessibility. After further pondering and discussing, the steering group decided that the analysis will look at the changes of accessibility on sustainable modes of transport and the changes in trip friction by public transport between the MAL 2019 plan and the alternative. Both the accessibility and trip friction analysis are performed with HELMET model.

The idea is essentially to understand the distribution of costs and benefits of the transport system. Both accessibility analysis and trip friction analysis present the distribution of costs and benefits, but the analyses have differences when used in regional planning context, and their applicability depends on how understandable the analyses are in a regional planning context consisting of a wide group of experts (figure 15). The pro of the trip friction analysis is that the concept is easy to understand (time + cost = trip friction), but the cons are that trip distribution has to be analysed with fixed demand, it does not consider the assignment, and that the term itself is not widely used in MAL planning. The pros of accessibility analysis are that the term accessibility is used widely in MAL planning and that the trip assignment can be analysed with logsum variable. However, the basis of the analysis is harder to grasp and since accessibility does not have generally accepted unit value, it is hard to portray as well.

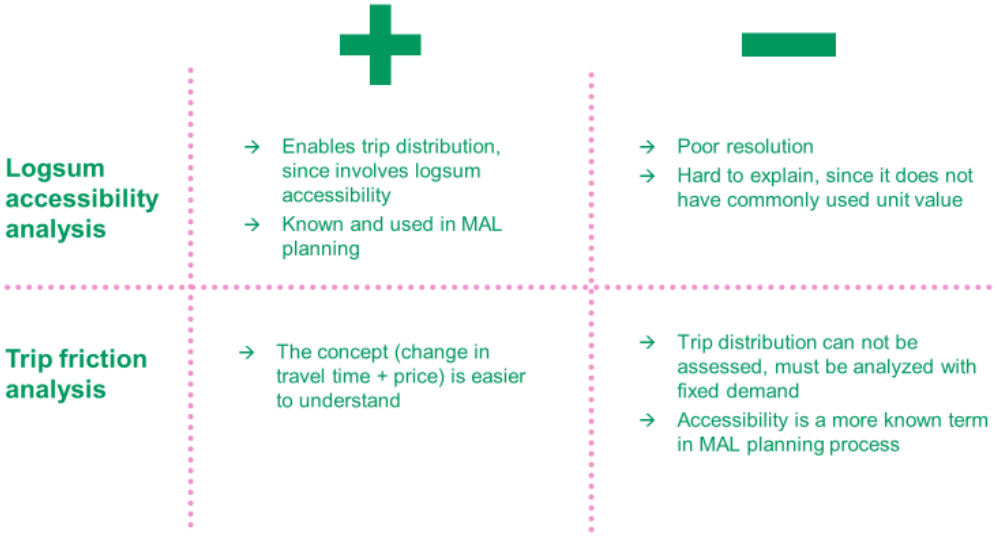

Figure 15. The pros and cons of the analyses.

The trip friction term is used to analyse the overall costs of the trip for the individual. Trip friction refers to a combination variable in which travel time and the cost of travel are combined into a single variable. The combining is done by multiplying the overall travel time by coefficient which commensurate minutes and euros. The transformation coefficient is the value of time which changes according to trip purpose. When analysing generalized trip friction of public transport, the travel time is multiplied with the value of time defined in social economic cost-effectiveness calculations. The travel time coefficients then depend on the trip group. (HSL 2017.) Trip friction is HELMET model's term for generalized cost which is the term usually used in transport economics of the same phenomenon.

The accessibility in HELMET model is analyzed with a logsum accessibility indicator. Logsum variable refers to the mathematical representation of accessibility. It is used in HELMET's trip distribution model to describe how accessible different destination options are with different modes. Logsum is a natural logarithm of mode choice model's denominator (Haapamäki et al. 2019). The denominator is the sum of the exponential function of whose argument is each mode's utility function (Ben-Akiva & Lerman 1991, read in Helsingin seudun liikenne 2019c). Logsum is calculated with function

$$\ln\left(\sum_{j=1}^{J} e^{U_j}\right)$$

in which U_j is the alternative j's utility function. (HSL 2019c.)

Once the trip friction analysis and accessibility analysis are completed, the results are portrayed in a map by QGis program. Afterwards, the income level distribution is transposed onto the same map to visualize the distribution of income level on the HELMET model zones. In addition, some calculations are used to analyse the distribution of accessibility changes and trip friction changes on different income level groups.

The geospatial data of income levels is gained from Paavo database which is an open source geospatial database by Statistics Finland. The data is provided by postal code areas; hence it is not equivalent to the HELMET model zone division. A data combination was performed in order to enable the analysis. The analysis includes residents of different income levels: low income, middle income, and high income. The income level is determined by the resident's disposable monetary income consisting of wage income, entrepreneurial income, capital income, and received income transfers, minus payable income transfers. The low-income group consists of residents whose disposable monetary income level is at most 12 815 euros per year. The middle-income group consists of residents who earn between 12 815 euros to 30 897 euros per year. The high-income level group earns over 30 897 euros per year. All in all, the data considers 1 120 022 residents of Helsinki region who are over 18 years of age. The data is from year 2015. (Statistics Finland n.a.) The data shows that most of Helsinki region residents belong to the middle-income group presented in figure 16. However, almost a fifth of Helsinki region's residents belong to the low-income level.

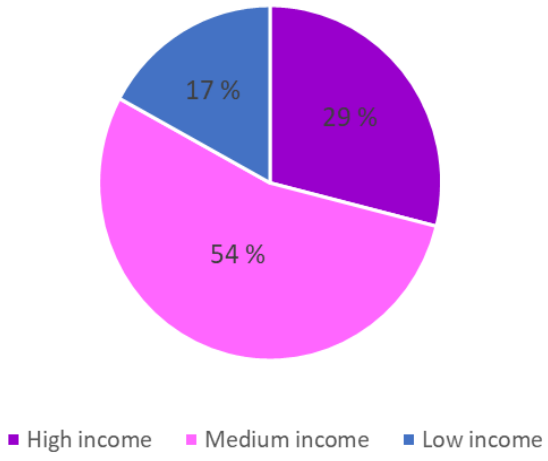

Figure 16. Income distribution in Helsinki region.

3.2.2 Helsinki region's transport model HELMET

The accessibility analysis and the trip friction analysis utilized in the thesis are produced by the Helsinki region's transport model HELMET. This section does a brief overview of the models of HELMET model and their functionalities.

HELMET model is an implementation of a four-step model which models and predicts the transport for the Helsinki region's 14 municipalities. The model divides Helsinki region and its peripheral municipalities into 1918 zones and forecasts the transport in between them. This research focuses only on the Helsinki region and as such utilizes the Helsinki region specific 1753 zones. The modelled zone division is based on the statistics' areas of the municipalities. The sizes of the zones change according to the population density of the zone so that the denser the zone, the smaller the size of the zone in the model and vice versa. (HSL 2016.)

Travel demand is predicted based on data from land use, population, transport system, travel time and travel costs. The trip generation phase predicts the number of trips based on data from land use, population, and demographics. Trips are divided into six types: home-based work and study trips, home based school trips, home based shopping and activity trips, home based other trips, work-based trips, and other than home- or work-based trips. The number of trips is predicted for each trip type separately. (ibid.)

Trip distribution model and modal split model are logit models. Trip distribution model predicts the trip destinations according to trip types. Trip distribution models explain trip destination choice through the logsum of modal split model and a growth factor. The modal split model's logsum describes the easiness of travel between zones and the growth factor describes the activity possibilities in each destination. Trip distribution models' premise is that the more activity possibilities a zone has, the more attractive it is for people to travel to. The growth factor describing the number of activity possibilities is determined by the amount of jobs and study places in the case of home-based work and study trips. In the case of other trip types, the activity possibilities are determined by the population amount and the number of service and store jobs. Home based school trips are an anomaly in trip distribution models since the destination is predicted by the length of the school trip and the population amount. The more activity possibilities a zone has and the easiness of traveling to it, the more likely it is that the zone will be chosen as the destination. (ibid.)

Modal split model predicts whether trips are made by car, by walking, by public transport or by cycling. First, the model predicts whether the trip will be made by walking or with other modes. This choice is predicted by factors describing the zone's walkability and the possibility to use a car. After this, the trips that are made by other than walking are predicted a mode choice from cycling, public transport or car. The choice depends on the time spend on travel, the cost of travel, and the possibility to use a car for each mode. (ibid.)

The last step of HELMET model is traffic assignment where the predicted trips are assigned to the road network. This step represents the route choices people take and gives an overview of the traffic volumes and congestion in the road network. The network assignment happens according to an idea that traffic aligns on the road network in a way that no user can switch their route in order to make their trip faster. The speed on the road

is defined in the model by the road delay function which determines the speed according to the road qualities and the number of cars on the road. (ibid.)

After the traffic assignment, depending on the destination and mode choices, travel times between different zones might have changed from those to which at first the traffic distribution and modes were predicted to. Since the traffic distribution model and mode choice model utilize the easiness of travel between zones and travel times with predictions, HELMET model has a feedback loop in between traffic assignment, traffic distribution and mode choice models. In addition, mode choice model and the traffic distribution model have a connection through mode choice model's logsum. While calculating predictions, the models are run through 10 times so that each time the model takes the results of the previous rounds and uses them as the starting point for the next round. This is done so that results would condense towards the equilibrium defined by the urban structure. (ibid.; Haapamäki et al. 2019.)

4 Results

This section presents the results gained from the workshop and the case analysis. Section 4.1 considers thoroughly the insights gained from the workshop. Section 4.2 considers the formation of the social and distributional impact assessment matrix. Section 4.3 presents the results of the case analysis.

4.1 The social and distributional impact assessment framework

4.1.1 Thematic analysis on the regional workshop

The workshop started with questions which were designed to awaken the conversation in order to encourage the discussion through socialization. Socialization provides a platform where experts can learn from each other's concepts of reality, professional language, and views of the planning object (Te Brömmelstroet and Bertolini 2010). The objective was to get the experts talking and engaging with each other and to test the concepts of social and distributional impacts on the regional experts. The workshop succeeded in encouraging conversation which in the end was quite lively and considered many viewpoints. The discussion topics involved specific infrastructure projects, the social and distributional impacts relevant in Helsinki region's context, equity of transport systems, the impact assessment process, and methodology of impact assessing. Based on the discussions, the analysis that follows is divided into themes than include both content-related discussion and methodology-related discussion. First, we shall analyse the content-related discussion on social and distributional impacts in the Helsinki region.

The content-related discussion contains the discussion topics which relate specifically to the social and distributional impacts of transport system. A topic which occurred in each discussion group was the conversation on *the necessity of the impact assessment development project*. The importance of the ongoing development project was widely recognized in order to achieve sustainable transport systems. One topic that emerged in the groups was the fairness of transport systems. One expert stated that providing regionally comprehensive and affordable public transport is a question of equity and it should be provided for different socio-demographic groups equally. Another expert pointed out how the region is extremely versatile and the need for sustainable modes in also the outer areas of the region needs to be considered and provided. The discussion also considered intergenerational equity of residents, as for whom is the region planned for. It was also stated that this is a somewhat philosophical question which also considers viewpoints on how we see humans: as victims of circumstances or as independent actors.

The social impacts of transport in the context of Helsinki region were discussed in depth. Health impacts were addressed on multiple occasions. *Traffic safety* impacts were recognized as an issue in both the centres and the outer areas of the region. Especially school trips and trips with active modes were seen unsafe in certain areas. *Local pollution* (local emissions and noise pollution) caused by road and air traffic was seen problematic, although it was recognized that understanding and addressing the issue has improved in planning practice in recent years, especially in relation to noise pollution. At the same time, it was noted that local emissions are not considered enough since detailed planning

still designs housing close to local emission intensive locations. It was also said that even though the impacts of local pollution are known, the decision-making does not always necessarily support nor utilize this knowledge. It was also noted that developing *active modes of transport* should still be advanced since its impacts are mostly only positive. *The impacts of barrier effects* in Helsinki region were addressed and barrier effects caused by transport infrastructure was recognized as an issue all around the region, especially the areas close to regional rail tracks. It was recognized that the future regional rail tracks will inevitably divide residential areas, e.g. possible future rails to Turku via Espoo and Lohja.

Equity factors were discussed in each group in relation to the social impacts of transport in Helsinki region's context. The discussion circled the topic of who gets what and who benefits and who does not. The experts recognized many *equity disparities* in the Helsinki region. One disparity was the rising land prices due to improved accessibility from new transport infrastructure and how the land price benefits are unequally distributed in the region. Other disparity relates to the public transport service level with striking differences between the region's central and outer areas. The experts also realized that since Helsinki region is wide and versatile, the public acceptance and the perceived fairness is essential in relation to the acceptance of future transport policy measures, e.g. possible road tolling scheme.

In addition, *affordability* was discussed in its different forms. Some discussed the subject of affordable travel on different modes and the possibilities for travel in various parts of the region. This discussion shaped into a discussion on whether there is transport poverty in the region in different areas. Others converged about the affordability of housing in different locations of the region and its relationship to accessibility. It was noted that people do make active decisions while moving to areas of less accessibility to gain affordable housing. The relationship of housing prices and accessibility was not seen as unequal per se.

The question *what should be further studied* encouraged a lively discussion among the experts which ended in multiple future case study options. Different issues in need of future consideration to mention a few were the public service network and its accessibility, intrinsic travel and leisure time travel, happiness on areas of varying levels of accessibility, stress reduction on travel chains, traffic safety issues, and transport poverty connected to the equity of transport. In addition, the experts also discussed the need to study transport sector's greenhouse gas reductions and its social impacts. Specifically, how does transport greenhouse gas emission reductions affect people's everyday lives. This specific workshop question was formed to gain insight on what impact should be analysed further, however, the question stirred up so many ideas that no one study option was singled out for this purpose.

One aspect did, however, stand out during the workshop. *The distribution of impacts* was discussed on in each group on many occasions. The experts agreed that the socio-demographic distribution of costs and benefits is something that is not currently assessed in MAL planning and perhaps it should be. The concern seemed to be that planning practice might have a blind spot in the matter. The topic included the discussion on what are the socio-demographic groups that should be studied, and should the focus be on groups that are the most vulnerable in the region. The discussion involved what are the vulnerable groups and how should they be defined. Different socio-demographic groups were men-

tioned, for example, visible minorities, elderly, low income level, but no specific definition was mentioned. One expert mentioned that the socio-demographic impact assessment related to gender is even in the current government's budget. In addition, the temporal distribution of impacts stirred up in the conversations. It was noted that public transport service level during weekends differs from the service level on weekdays, and that this is currently not addressed. The discussion was based on a topic about how in order to tackle transport sectors' CO_2 emission reductions, the sustainable modes should be more accessible during also off-peak times.

In addition, *accessibility impacts* were discussed on multiple occasions. It was noted that accessibility is already studied in MAL planning impact assessment quite thoroughly, and there were points made that there might necessarily be no further need to consider it even more. At the same time, it was noted that the assessment of accessibility distribution still lacks for example assessment of socio-demographic groups or analysis of the differences in accessibility temporally. Temporal accessibility notes related to the difference of accessibility during varying times of day, especially off-peak hours. Experts said that even highly accessible areas can be poorly accessible at night, for example, Meilahti hospital area. Discussion on the socio-demographic distribution of accessibility assessed the different capabilities different groups of people have for movement. Experts discussed how some people are not able to walk their journeys perhaps due to poor health. Some are, on the other hand, not able to use a car possibly due to age or income-level. One expert also noted how digital accessibility could be an aspect to investigate as well since public transport information and ticketing is located nowadays mostly in digital form. It was noted that accessibility has been assessed quite a lot in MAL planning impact assessment process, but not necessarily from these points of views.

The methodology-related discussion concerned the data of impact assessment, indicators, and the impact assessment process itself. The experts pointed out the necessity for a useful social impact assessment methodology that can be utilized in practice. This discussion involved aspects such as how can we measure social impacts, what should be the indicators and what is the data needed for the analysis.

Discussion about data circled around what *data* is currently available. The experts expressed some doubts on the current data availability, especially in relation to data on socio-demographic groups. It was noted that Finland does not currently collect the same kind of detailed data, for example, on minorities as some countries do. There exists data on language minorities, but not data based on nationalities or races which was also seen as a good thing. It was noted, however, that multiple sources for statistics data combined with geographical information exist and could be utilized, e.g. income-level. The experts discussed how data could be gathered also through surveys. Survey data stirred up conversation about survey data bias and how some people, especially the vulnerable groups, usually do not answer to the surveys. As such it can be hard to gather the needed information this way. Additionally, the discussion on data evolved to a conversation about what is the baseline of the social impact assessment and how can it be defined. The experts noted that baseline is necessary in order to do any impact assessing but the problem seemed to be how to define a baseline for such a broad impact assessment.

Indicator discussion related to the discussion on data collection. It was mentioned how most likely the social impacts cannot be measured thoroughly with just one indicator of social impacts since the field is so broad and filled with many different impacts. Hence, there should be multiple indicators and an impact matrix of sorts. One expert noted how

some impacts can be most likely measured only through data retrieved from specifically designed surveys. A few examples of indicators were mentioned: travel time ratio between sustainable modes and personal motorized vehicles, and a multiple indicator assessment using GIS data. The experts discussed how utilizing Helsinki region's HELMET transport model could be an asset. At the same time, it was said that an activity-based model which focuses on the individual could be even more beneficial although currently non-existent in the Helsinki region.

Different *levels of planning* were mentioned multiple times. One expert pointed out how social impacts could be analysed in the ex-ante and ex-post assessments of different transport infrastructure projects, for example with project such as the Ring Rail line, indicating that social impacts could be assessed on a project level. One expert pointed out how it is very difficult to assess walking surroundings of the built environment on a regional level and perhaps it should be considered on a detailed planning level. The same was mentioned in relation to assessing the impacts of barrier effects. It was noted that capturing the impacts of barrier effects is very hard on the regional level and should be done during infrastructure project assessments. Detailed assessment of impacts of barrier effects was understood to belong to detailed planning. Regional level planning should, however, recognize the impacts of barrier effects that new infrastructure will most likely have.

In conclusion, the methodology discussion concerns the practicalities of planning and is key for understanding what is needed from a method for studying social impacts. It defines which impacts can be analyzed now with current methods, which impacts should be studied on other planning levels than the level concerning the MAL impact assessing, and which impacts cannot be studied currently due to lack of data or methods but could be analyzed later with perhaps future data sources or with data acquired through surveys.

Figure 17 presents the themes of discussion topics from the workshop organized by content-related discussion and methodology-related discussion. As the figure shows, not all social impacts of transport that were introduced in the background section of the thesis were mentioned in the workshop. This is understood to indicate that not all social impacts of transport were assumed to be as relevant for Helsinki region as others according to the experts. However, the reason for the lack of comments might also indicate that some impacts presented in the beginning of the workshop are commonly known in the planning practice, and in this case, perhaps the experts did not think them worth mentioning. Other assumption for the lack of comments is that some of the social impacts might have been new to the experts which can make it hard to discuss about them right away. One very practical reason for the lack of comments might also be that the note takers did not have time to write everything down. Because of the abovementioned reasons, the following section which considers the forming of a social impact assessment matrix considers all the social and distributional impacts of transport that were mentioned in the background section, however the workshop discussion and the previous MAL impact assessment material will steer the formation.

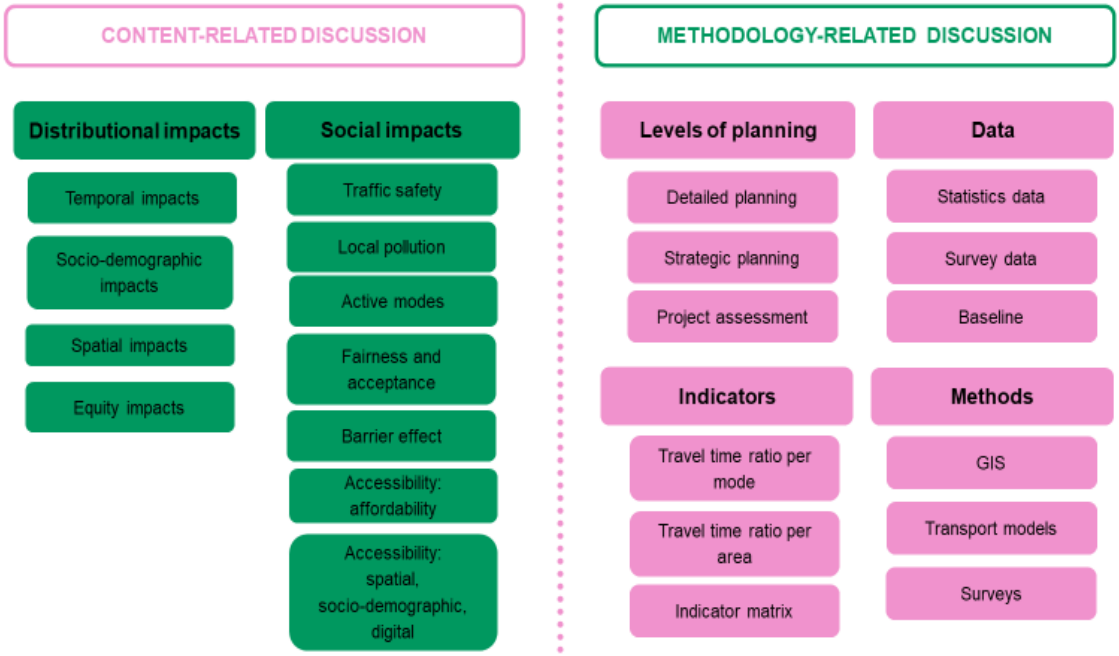

Figure 17. Workshop's discussion themes organized based on content and methodology.

4.1.2 The social impact assessment matrix

One of the goals for the thesis is to form the social impact assessment matrix for the future MAL planning cycles. This is done by combining the knowledge gathered from the background section, the tacit knowledge of the experts gathered from the workshop and the knowledge gathered from the previous MAL impact assessment material. In addition, the notes and guidance of the thesis steering group will be considered comprehensively. The assessment matrix will present a general view on the social impacts of transport that should be assessed in the MAL planning process in the future. The idea is that, as with MAL 2019 impact assessment matrix, the social impact assessment matrix will demonstrate the focus of the assessment from a more general viewpoint and will highlight that aspects that need to be considered in the future.

The matrix is formulated with the help of three premises. The premises will act as a filter that steers which impacts can be considered. The premises are the following:

- **The levels of planning**. What are the levels of planning in which the social impacts of transport should be assessed? Levels of planning define how detailed an assessment can and should be.
- **The method of assessment**. Which impacts can be assessed in an iterative planning process, such as the MAL impact assessment process, and which impacts cannot? The methodology defines whether impacts can be considered in an iterative way.
- **The input from the experts**. The gathered tacit knowledge from the workshop, steering group, and HSL experts work as a final filter throughout the matrix formation. It is important that the insights from the regional experts are thoroughly considered while formulating the matrix.

Starting off with **the levels of planning**, one of the goals for the thesis was to figure out how can the social implications of transport be assessed on both strategic planning and project planning levels. Hence, the first thing is to determine which social impacts should be assessed on which planning level. The division of impacts to planning levels is shown in figure 18. Since MAL planning occurs on the strategic transport system planning level, the key is to define which social impact should be assessed on the strategic level. Strategic level of planning literature is comprehensive and too wide to discuss in this research. The important aspect is to note that transport system planning combines land use and transport planning and, by definition, considers the broad, long-term effects occurring in the transport system (Herneoja et al. 2018). This means that the assessment cannot by default be too detailed.

Figure 18. The social impacts of transport divided into levels of planning.

The social impacts recognized in the background section that should be assessed on a strategic planning level are fairness and acceptance of transport system, active modes of transport, accessibility in relation to well-being and affordability, travel experience and intrinsic travel. All these impacts have long-term effects. Their assessment on a strategic level can give important insight to MAL impact assessing since these phenomena have impacts which are broad and systemic in nature. Almost all of the impacts were also discussed in the workshop.

The social impacts recognized in the background section that should be studied on a more detailed planning level or project assessment level are impacts of barrier effects, transport infrastructure impacts, the forced relocation of people, and perceived safety. Barrier effect and transport infrastructure impacts are specific to certain areas and to certain infrastructure projects. The impacts should also be understood and recognized on a strategic planning level. However, the type of more detailed assessment that barrier effects and infrastructure impacts would require is not possible on strategic planning level with current resources. Barrier effect and infrastructure impacts are also already considered at detailed planning level by the municipalities to a certain level. Forced relocation is currently rare in Helsinki region, but it does occur when big infrastructure projects are planned. Hence, this should be considered on a project level. Again, forced relocation is a phenomenon that is currently at bay due to the government-controlled rent markets. If this were to dissolve, forced relocation will most likely increase and then should be considered on the strategic planning level more thoroughly. Perceived safety is difficult to assess since the

initial data for the assessment should be acquired via surveys. However, ways to alleviate safety concerns are quite well-known in planning, and should be considered while doing detailed planning, e.g. designing new areas, stations, and transport routes. In conclusion, even though impacts of barrier effects, forced relocation infrastructure, and perceived safety are long term, they are not necessarily systemic, and as such, should be considered on a more detailed planning level.

The impacts that should be considered on all levels of planning are related to transport externalities: traffic safety, noise pollution, and local emissions. Traffic safety, noise pollution, and local emissions all relate to people's health and well-being in a profound way and should, hence, be considered always on all levels of planning. These impacts have long-term effects on people's wellbeing and are both systemic and local in nature. These impacts were also emphasized and the need for better assessment in the region was presented during discussions with regional experts.

Next step is to take an in depth look on the strategic planning level and what is possible to assess with the current **impact assessment methods** of MAL planning process. One of the impacts that cannot currently be assessed in planning is *intrinsic travel.* According to the experts of HELMET model, the model does not currently support assessing trips that are made for the purpose of the journey itself, even though the HSL's travel survey, which works as the model's background information, does ask about the cause behind the trip. The assessment of intrinsic travel would require investing in the development of a method in order to be feasible for MAL impact assessing at this point. Therefore, the impacts of intrinsic travel are left out of the social impact assessment process and the matrix for now. However, MAL planning should recognize that this type of travel occurs, and that not all travel is derived demand as the current paradigm states.

Most of the social impacts of transport that have been assigned to the strategic MAL planning level are impacts that can be assessed in an iterative planning process. This means that the plan that is "under construction" can be tested with assessing its impacts in order to steer the plan in a direction that the impact assessment points to. The impacts that cannot be assessed in the iterative process currently are *travel experience* and *fairness and acceptance of transport system*. These impacts are essentially experience-based since it relates to *how people perceive* their travel experience and the fairness of transport system. The data for the assessment of these impacts should be acquired through surveys. A survey study is unfitted as a methodology for an iterative planning process, since survey production takes a lot of resources and cannot be repeated multiple times during the process. However, surveys can help with *monitoring* these impacts, and the results can steer the planning practice. Also, the surveys can be made a part of the planning process in the future.

The social impacts of transport that can be assessed in an iterative planning process are *traffic safety, noise pollution, local emissions, accessibility related to well-being and affordability,* and *active modes of transport*. These social impacts are labelled as **the core themes of the assessment** for three reasons. First, the impacts can be assessed with current impact assessment methods of MAL planning with perhaps slight modifications. Second, these impacts were discussed actively in the workshop and are as such assumed to be important in the region. Third, these impacts have been highlighted throughout the thesis writing process as issues of specific importance in the region in discussions with the regional experts and in the social impact literature. The whole social impact assessment matrix is presented in figure 19.

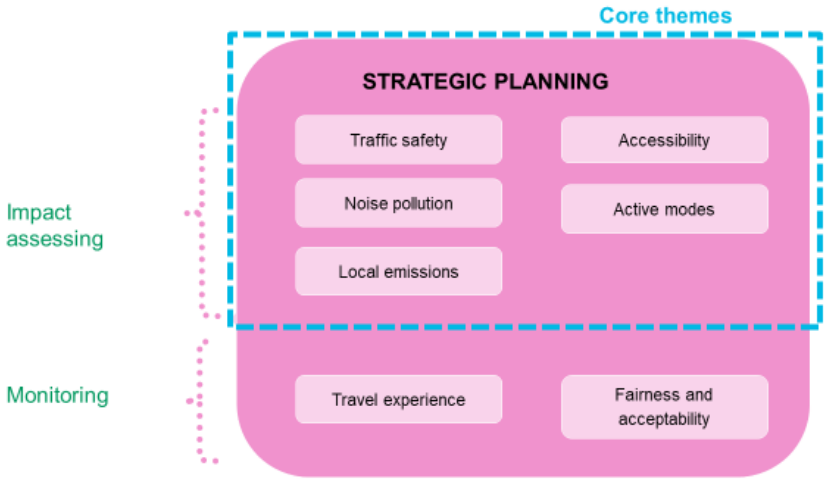

Figure 19. The matrix of social impacts of transport in strategic planning and the core themes of the assessment. Some impacts can be assessed through monitoring and some in an iterative impact assessment process.

All core themes are considered in the current impact assessment process, at least partly. However, the input gained from the workshop showed that the negative impacts of noise pollution and local emissions produced by traffic are not considered enough in the current planning processes in the region. The experts pointed out how, for example, day cares are still planned to busy transport nodal points, which are good locations considering accessibility, but tend to have high amounts of both local and noise pollution of which children are the most vulnerable to (Helsingin kaupunki 2019). Local emissions, noise pollution and traffic safety impacts are also considered in transport project appraisals while performing economic impact assessments, especially cost benefit analysis, (CBA) as costs of an infrastructure project or a policy measure. Nevertheless, a decision about a project or a policy measure is mostly done based on the net present value, and the costs behind the CBA are not usually highlighted after the net present value of a project or policy measure is presented. The CBA has also been seen to be inadequate to assess social and environmental issues. (Nyborg 2014; Anne Annema et al. 2015; Nurmi and Ahtiainen 2018). Hence, it has been noted that the assessment of transport externalities should be highlighted more in impact assessments. Accessibility is currently assessed quite thoroughly in MAL impact assessment process, however, the analysis on the distribution of accessibility impacts, especially on socio-demographic groups, could still be improved.

When considering the core themes of the social impacts of transport, most of the impacts on residents could be reduced with reductions in regional vehicle mileage since noise and local pollution, traffic accidents, and active modes all improve with less vehicle mileage. However, reducing regional vehicle mileage undoubtedly decreases regional workforce accessibility especially by car. The background literature on social and distributional impacts of transport and the equity of transport systems points that enabling accessibility is the best measure that transport system planning has for enabling the thriving of areas and residents (Martens 2017; Delbosc 2012). In a way, the possibility of movement is seen as more important than the costs from transport externalities. This is essentially a planning trade-off which should be considered carefully.

4.1.3 The distributional impact assessment checklist

The assessment of distributional impacts is a bit more complex to design into a matrix. First, as stated before, the distribution of impacts is not specific to only the social impacts of transport. They are just as important to recognize in assessing economic and environmental impacts of transport (Jones and Lucas 2012). Second, determining what is the significance of impact distribution changes case by case. This means that, for example, while assessing temporal distribution, assessing night-time accessibility of hospitals could be said to be far more important than assessing the night-time accessibility of an office building area. All the distributional impacts are not necessarily relevant in relation to all social impacts of transport. Hence, there should be no all-encompassing rule of what to assess each time. Nevertheless, some guidelines can be proposed.

The figure 20 presents a checklist for the assessment of the core social impacts of transport on strategic planning level and the distributional aspects related to them. The distributional impacts are divided into spatial, temporal and socio-demographic impacts in order to highlight the multidimensionality of the issue. The spatial aspects which should be considered in MAL impact assessing are the ones related to *remote* areas, *areas close to centers*, and *central* areas. Remote areas do face issues such as poorer accessibility and higher prices for traveling. The areas close to centers, such as suburbs, may also have issues with accessibility and poor service levels. The central areas do enjoy better accessibility but do have much higher costs of living due to the costs of housing and higher costs for everyday living, such as produce. Hence, this spatial division should be examined also in the future in MAL planning as it has been considered previously. The temporal aspects which should be examined in the future are *off-peak hour*, *peak-hour*, and *weekends*. As stated previously, the temporal aspects are important to assess in order to understand the differences in accessibility on different times and days. Temporal impacts are also important in understanding the highlighted effects of local pollution during peak-hour.

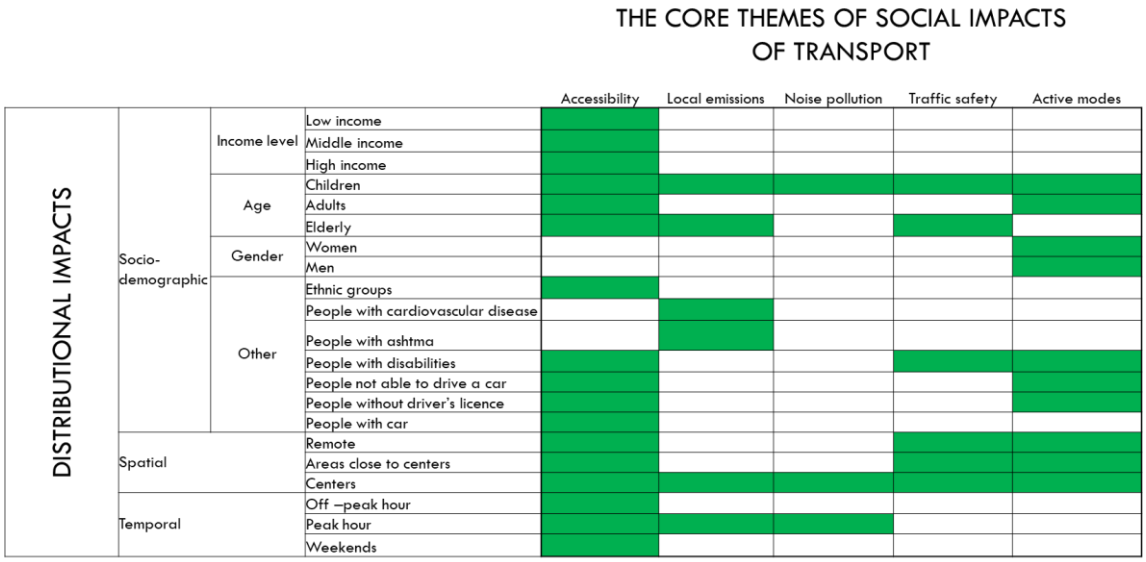

Figure 20. A checklist for the assessment of social impacts of transport and their distributional effects.

The socio-demographic impacts which should be considered in future MAL planning are related to *income level, age, gender, ethnic groups, individuals with disabilities, individuals with asthma or cardiovascular diseases, and individuals with cars, without cars, without the ability to use a car, or without a driver's licence*. Income level defines many aspects of individuals life, e.g. affordability for traveling. Therefore, it should be assessed further in MAL planning. Age relates on how sensitive one is to traffic safety issues, local emissions, and noise pollution. Age also determines one's accessibility since children and elderly may have issues accessing places by car. Gender relates to individual's mobility behaviour, and as such is a factor which should be examined or recognized in the future in the region. (Amundsen and Sundvor 2018; Markovich and Lucas 2011; Heltimo 2003; Atkins 2015.)

Ethnic groups are mentioned in the checklist in relation to accessibility, however, many aspects are involved when examining social impacts of transport related to different ethnic groups. The term itself is utilized based on the definition of Statistics Finland (Statistics Finland 2013). Ethnic groups are a very multidimensional group, therefore, a generalization for an assessment cannot be made. Nevertheless, it should be recognized that different ethnic groups may have specific issues related to transport. There should be more knowledge on the mobility behaviour of different ethnic groups and the issues they may or may not face while traveling. (Jones and Lucas 2012.)

Individuals with cardiovascular diseases and asthma are more sensitive to the traffic-related local emissions. They should be considered while assessing impacts of local emissions and how and where to reduce them. Individuals with disabilities should be considered while assessing traffic safety, but also accessibility especially on sustainable modes, since many individuals do depend on public transport for traveling. Finally, one important aspect is to consider individuals with cars and individuals who do not have a car or do not have the possibility to use a car, or do not have a driver's licence. Accessibility is still very much depended on having a car. If one has a car, the ease of travel is in a way guaranteed, at least if the individual can afford it.

The checklist works as a reminder to consider different aspects and different individual stratifications related to transport. Since travel behaviour consists of multiple aspects such as individual's needs, wants, habits, and time budget, individuals are determined to have more stratifications which should be considered depending on the case in point. There are loads of different individual stratifications that shape our travel habits. The point is that individuals are not just users of a certain mode of transport, so there are other factors which also are important when analysing transport. In other words, people have multiple layers which determine their travel and these layers should be considered more thoroughly in the future MAL impact assessing.

Most importantly, the analysis of the socio-demographic distribution of impacts should in the end focus on analysing the least disadvantaged and vulnerable groups that may experience the negative impacts of transport the most. The checklist reminds the planner to focus the distributional impact assessment on the specific disadvantaged and vulnerable groups that are relevant for the particular planning case at hand. Transport measures should enable the most vulnerable, not disadvantage them more, as according to the Rawlsian difference principle (Halmetoja 2012). Therefore, it is necessary to make sure that planning does not create negative impacts on groups and individuals who are less advantaged already.

4.2 Results of the case study

This section shows the results of the case study. First, I will discuss the results of the trip friction analysis on public transport. Second, I will present the results of the workforce accessibility analysis on sustainable modes of transport. Finally, I will present the results on the changes of trip friction and accessibility distribution on income levels.

The case analysis focuses on the distribution of costs and benefits of the MAL 2019 plan. The costs in this context relate to either increase in trip friction by public transport or reduction of workforce accessibility on sustainable modes of transport. The benefits on the other hand refer to reductions in travel times and general trip friction or improved workforce accessibility on sustainable modes.

4.2.1 The changes on trip friction by public transport

The trip friction analysis studied the changes on trip friction by public transport between the alternative and MAL 2019 plan. The analysis shows that the MAL 2019 plan reduces the trip friction by public transport in many parts the region which is mostly due to the proposed comprehensive transport infrastructure project listing. The figure 17 shows the relative change in trip friction in the Helsinki region. The areas portrayed in red and orange are the ones with the most increase in trip friction. The areas portrayed in blue and green are the ones benefiting the most from the reductions of trip friction. The areas portrayed in light yellow are the ones where trip friction does not increase nor reduce that much. The maps are divided into zones which are the 1753 zones of HELMET model where the changes in trip friction are calculated on. The unit value for trip friction is in euros since trip friction consists of calculating travel time and travel costs and multiplying with the coefficient value of time.

The new transport infrastructure projects increase the regional public transport service level and speed of public transport in almost all parts of the region. The plan reduces trip friction especially nearby new rail and tram stations, e.g. Vantaa tram, Espoo tram, Viikki-Malmi tram, and new Kerava-Nikkilä railway for passenger traffic shown more precisely in figure 21. The increased service intervals on already existing railway lines, such as line Z, also reduce trip friction around current railway stations, e.g in Mäntsälä. In addition, the planned regional cordon-based road tolls reduce congestion on the regional road network comprehensively and increase traffic flow on also by public transport.

The areas where the trip friction increases are situated mostly in western Sipoo and in western Vantaa. The Kerava-Nikkilä railway connection for passenger traffic in western Sipoo does reduce trip friction nearby planned stations, however, it increases trip friction significantly in areas where current service level is based on the direct bus lines from Nikkilä to Helsinki city center. When the Kerava-Nikkilä railway passenger traffic begins, the direct bus lines to Helsinki will end since it's not cost-efficient to continue the current connections in combination with the new passenger rail connection. A similar change in direct bus line connections took place also in Vantaa after Ring Rail line traffic

began. The ensuing feeder connections from these areas to the new Kerava-Nikkilä stations will increase the trip friction of these areas significantly since the residents will have to divert first to the stations, then take the train to Kerava, and then possibly continue their trip to the capital region. The trip friction increases also in western Vantaa due to the new layover stop built on Ring Rail line in Lapinkylä. The layover stop is an essential part of the planned Pisara rail connection where the trains can equalize their travel time in order to decrease disruptions. The layover stop slightly increases trip friction nearby Aviapolis, Airport, Kivistö and Vehkala Ring Rail stations in western Vantaa. The results show an increase in trip friction by public transport close to the interchange of Ring Road I and Tuusulanväylä. This is a possible glitch in the model resulting from the encoding of the road toll system.

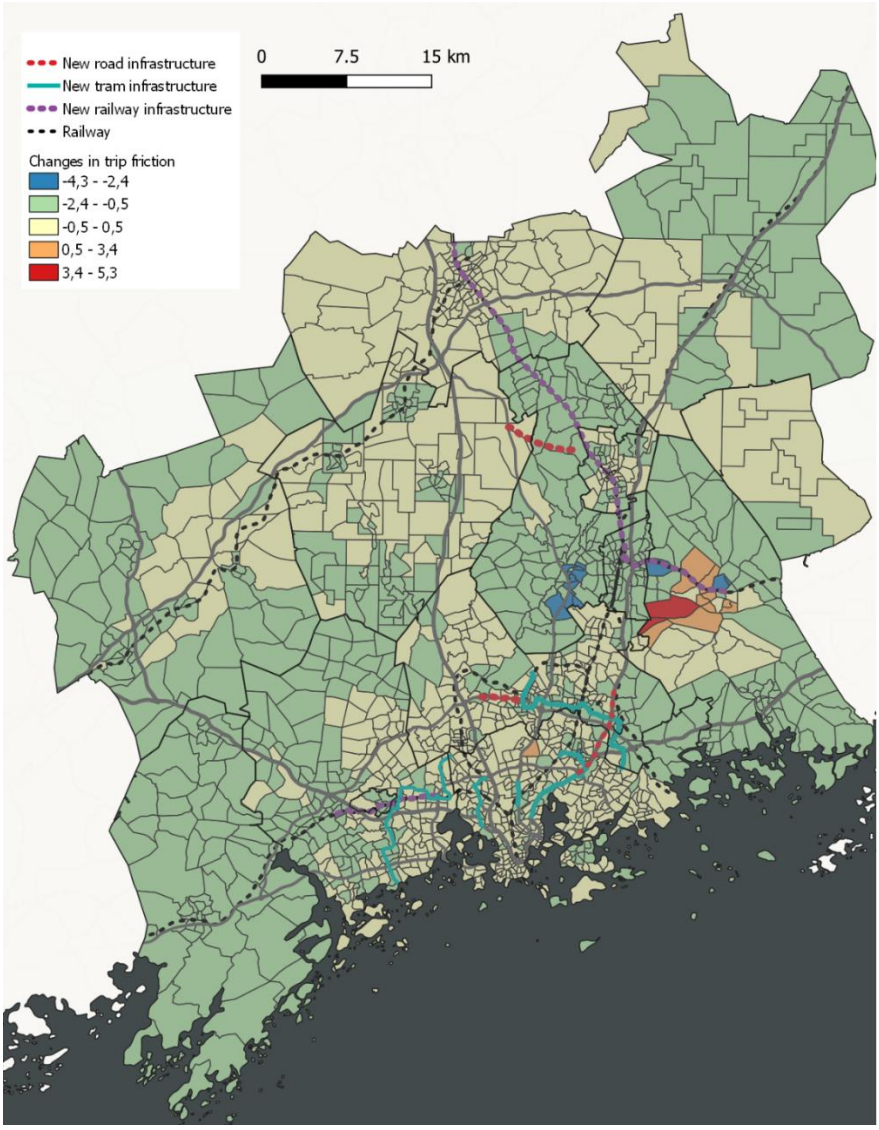

Figure 21. The change in generalized trip friction by public transport during morning peak hour in 2030 in Helsinki region. Trip friction unit value is in euros.

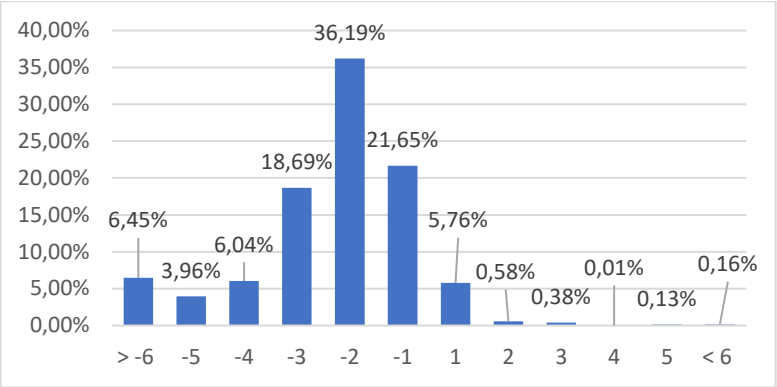

Figure 22. The change in trip friction on public transport on peak hour in 2030 distributed on residents of Helsinki region (y-axis). Trip friction change is shown in minutes (x-axis).

Figure 22 shows how most of the region benefits from the MAL 2019 plan compared to the alternative. Almost 93% of all residents of the region gain reductions of travel times, hence almost all residents benefit from the plan. Figures 23 and 24 show the changes in travel times on capital region and Kuuma region. The residents in Kuuma region gain the biggest travel time savings by public transport from the MAL 2019 plan. This is most likely since Kuuma region has previously endured longer travel times than the capital region due to longer trips both in duration and length. The cordon-based road tolls, the new railway infrastructure, and the increased service level on already existing rail connections all contribute to the reductions of travel times specifically in the Kuuma region. The travel time increases on the Kerava-Nikkilä passenger rail connection can be seen in figure 21 which shows the residents that endure more than 6-minute increases in travel times due to the MAL 2019 plan. Luckily, as the figure shows, the number of residents the travel time increases fall upon to is rather low. The capital region also benefits from the MAL 2019 plan (figure 24). The new tram connections of Vantaa, Espoo and Viikki-Malmi all contribute to reductions in travel time on areas where the tram infrastructure is built on. The region is affected by some travel time increases due to the aforementioned new station on the Ring Rail line in Lapinkylä and the possible glitch in the model from the road toll system.

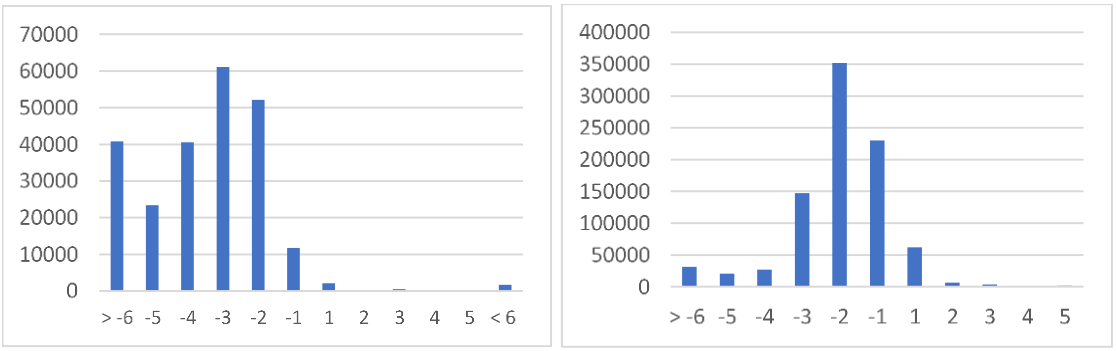

Figure 23 shows the change in trip friction on public transport on peak hour in 2030 distributed on residents of Kuuma region. Figure 24 presents the change in trip friction on public transport on peak hour in 2030 distributed on residents of capital region. The change in trip friction shown minutes in x-axis. The number of residents shown in y-axis.

MAL 2019 plan decreases travel times by public transport during morning peak hour in 2030 on average by 2,5 minutes in Helsinki region (figure 25). Kuuma region gains the most with a mean average of over 3 minutes of trip friction reduction. The capital region gains a 1,7 minutes of trip friction reduction on average.

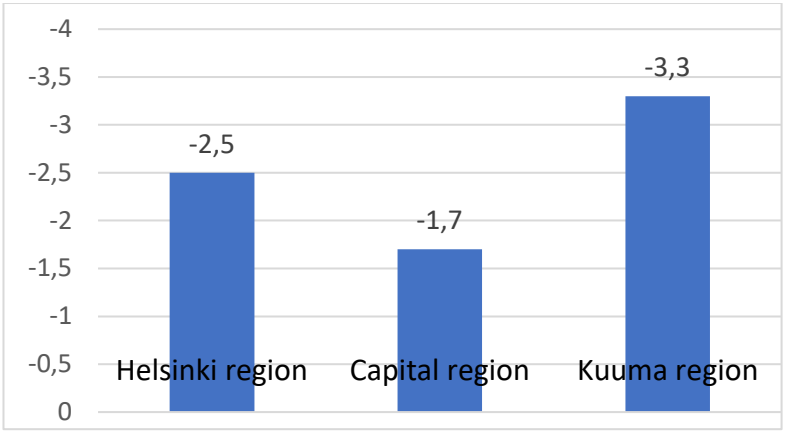

Figure 25. The mean change in travel time by public transport during morning peak hour in 2030 in Helsinki region, capital region, and Kuuma region. The change in trip friction shown in minutes.

When looking at the distribution of changes in generalized trip friction in Helsinki region, the distribution differences follow the same trend (figure 26). Kuuma region still gains the most from MAL 2019 plan with reductions in generalized trip friction of approximately 0.7 € per trip while the capital region gains a reduction of approximately 0.5 € per trip. The proposed reductions in public transport ticket prices in MAL 2019 plan even the differences in between the Kuuma and capital region, since capital region receives slightly more reductions in public transport ticket prices. All in all, general trip friction reduces by around 0.6 € per trip in the Helsinki region.

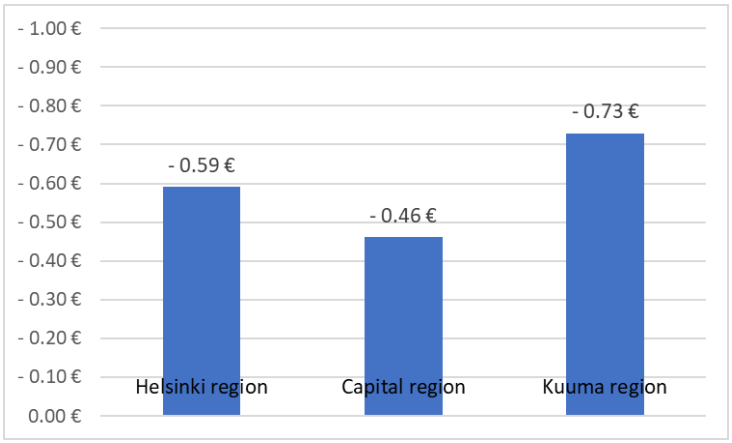

Figure 26. Change in generalized trip friction on public transport during morning peak hour in 2030 in Helsinki region, capital region, and Kuuma region.

4.2.2 The changes of workforce accessibility on sustainable modes

The accessibility analysis studied the change in workforce accessibility on sustainable modes between the MAL 2019 plan and the alternative. The logsum accessibility does not have a universally accepted unit of measure, however, the rule of thumb for understanding the results is that the more the workforce accessibility improves, the higher are the logsum accessibility unit values. The results show that MAL 2019 plan improves the workforce accessibility on sustainable modes throughout the region during morning peak hour. The biggest beneficiary is again the Kuuma region with the most accessibility gains on sustainable modes during morning peak hour (0.25) compared to the accessibility gains in the capital region (0.16). This is a logical outcome, since capital region already enjoys better accessibility on sustainable modes than the Kuuma region. Hence, Kuuma region has more accessibility to gain from the MAL 2019. The Helsinki region overall workforce accessibility on sustainable modes during morning peak hour improves 0.16 (figure 27).

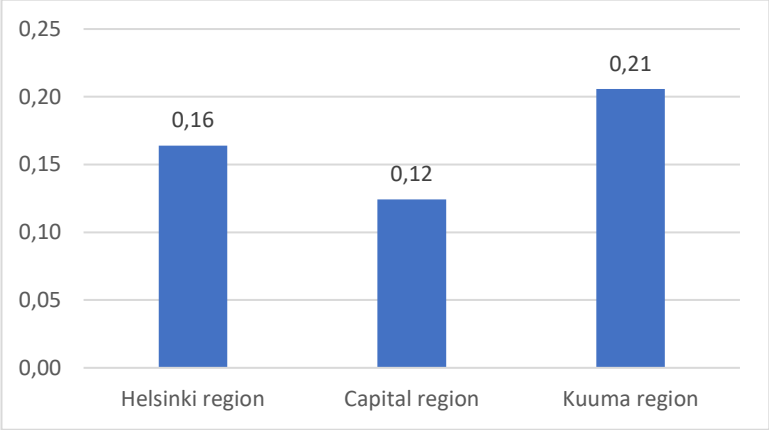

Figure 27. The mean change in workforce accessibility on sustainable modes transport during morning peak hour in 2030 in Helsinki region, capital region, and Kuuma region.

The map portrays workforce accessibility on sustainable modes of transport during morning peak hour. The red and orange in figure 24 indicate areas with least changes in accessibility, whereas the blue and green areas indicate areas with the most changes in accessibility. The yellow areas indicate that no essential changes in accessibility occur. As in the trip friction analysis on public transport, the new Kerava-Nikkilä passenger railway connection can be seen to create the most issues on workforce accessibility on sustainable modes of transport due to the removement of direct bus connections from Nikkilä to Helsinki. However, all in all the region seems to only gain from the MAL 2019 plan.

The analysis of workforce accessibility on sustainable modes considers also cycling on top of public transport, which the trip friction analysis for public transport does not. With cycling included in this analysis, the figure 28 seems to portray that more areas are gaining from the MAL 2019 plan compared to the trip friction analysis. Cycling increases the overall workforce accessibility on sustainable modes since the regional biking network improves due to the MAL 2019 plan, for example with regional cycling highways which are included in the HELMET model network for 2030. Hence, the analysis of workforce accessibility on sustainable modes is more comprehensive since it includes also cycling

and portrays a more thorough analysis of the plan with an overall view on the effects of the plan.

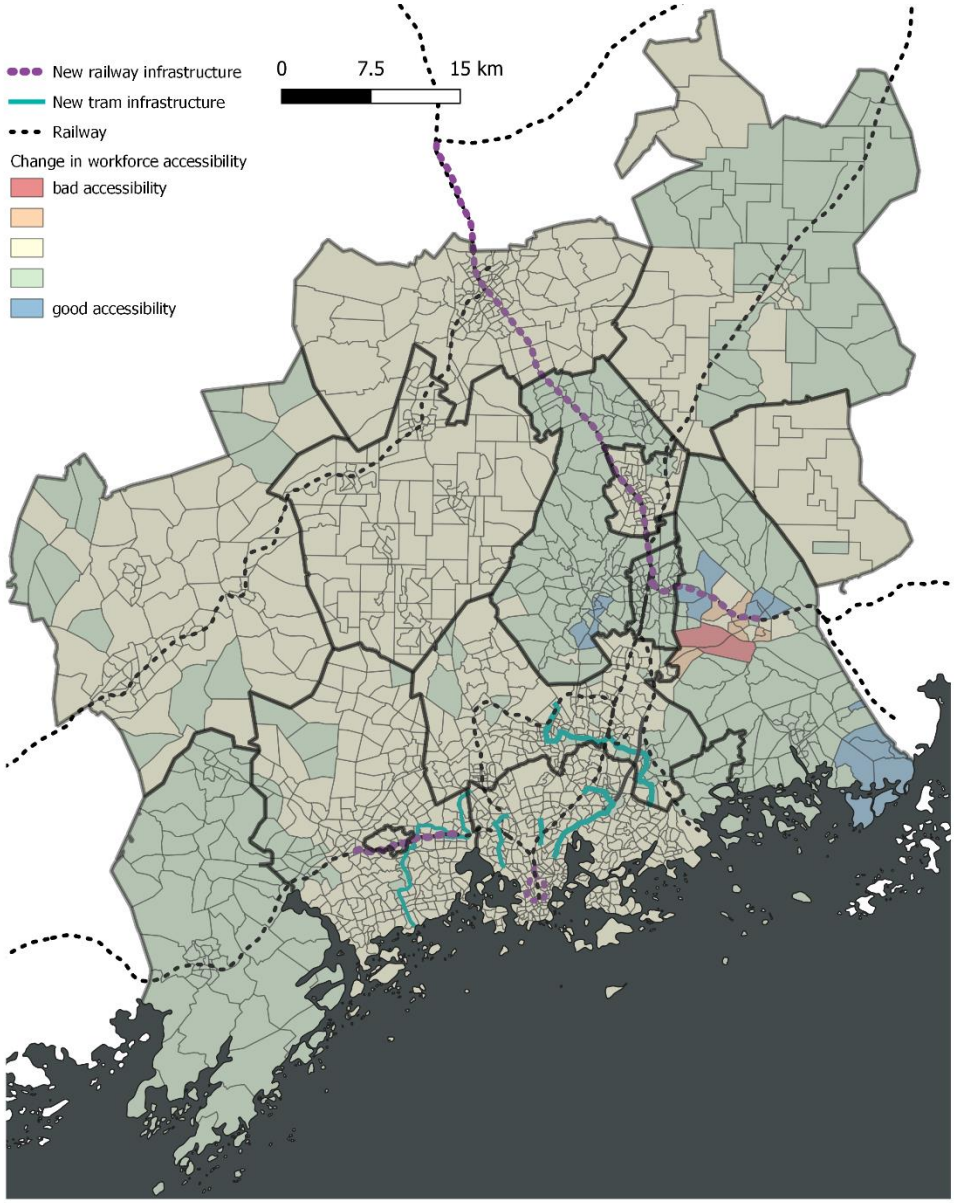

Figure 28. The relative change in workforce accessibility on sustainable modes of transport during morning peak hour in 2030 in Helsinki region.

4.2.3 The spatial and socio-demographic distribution of costs and benefits

The income distribution map shows that income levels are distributed unevenly in the Helsinki region. The income level distribution is visualized on top of the trip friction analysis. The figures 25 and 26 show the income level distribution portrayed as pie charts on areas where the percentage of residents of low-income level is either 20% or more. The pie charts show the share of low-income residents portrayed in red, the share of middle-income level residents portrayed in grey, and the share of high-income level residents

portrayed in green. Even though the figures 29 and 30 portray only the areas where there is some low-income level stratification, individuals of low-income level reside all over the Helsinki region. However, in order to highlight the areas with more low-income level stratification and to ensure a clearer visualization, it was decided to only present these areas where at least 20% of residents may have issues of affordability. Out of all the 1753 zones of HELMET model used in the analysis, only 288 zones are areas with low income stratification. This stratification does not mean that the areas would be suffering from social exclusion or segregation, it merely means in this context that a rather high proportion of individuals residing in the area may have issues with affording transport.

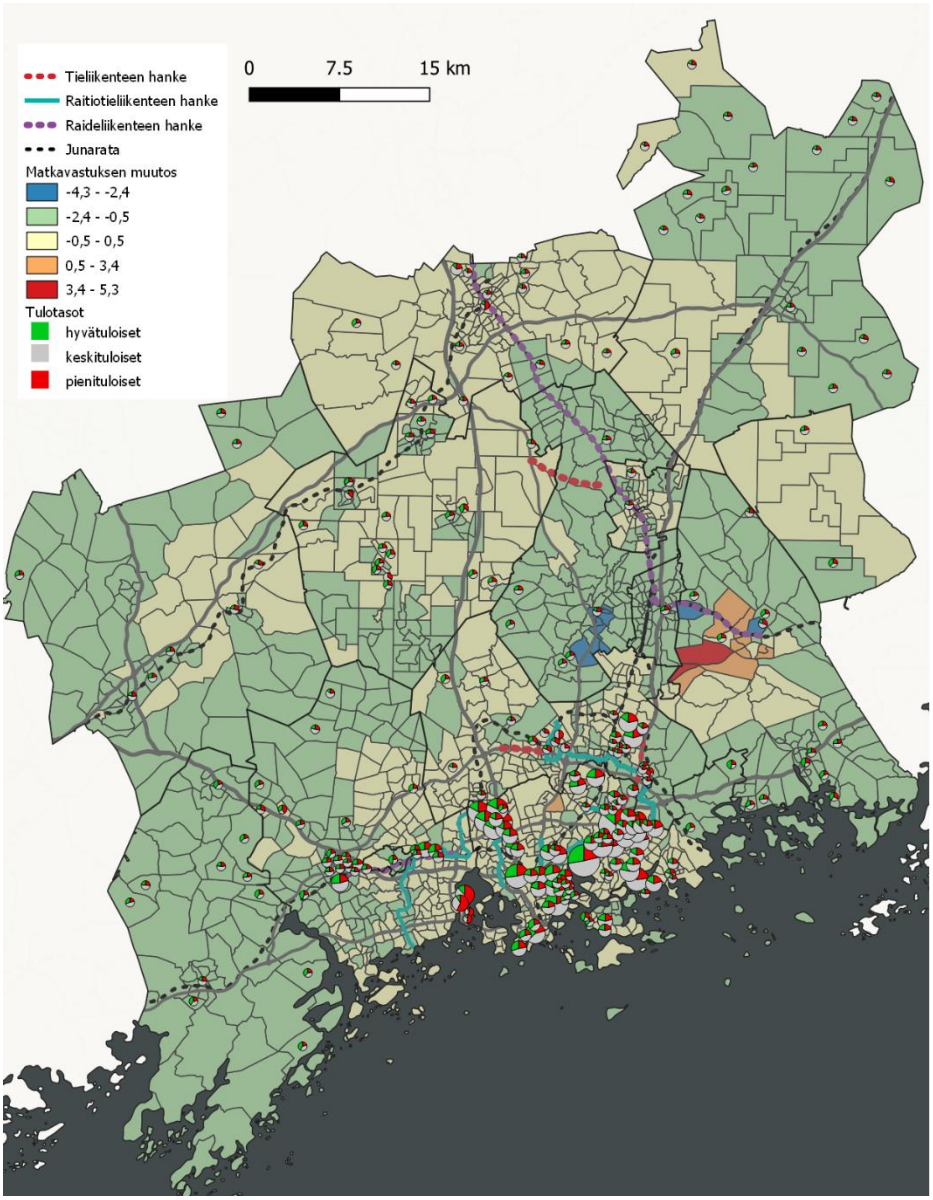

Figure 29. The change in trip friction by public transport during morning peak hour in 2030 distributed on Helsinki region and the areas where the percentage of residents of low income is 20 % or more.

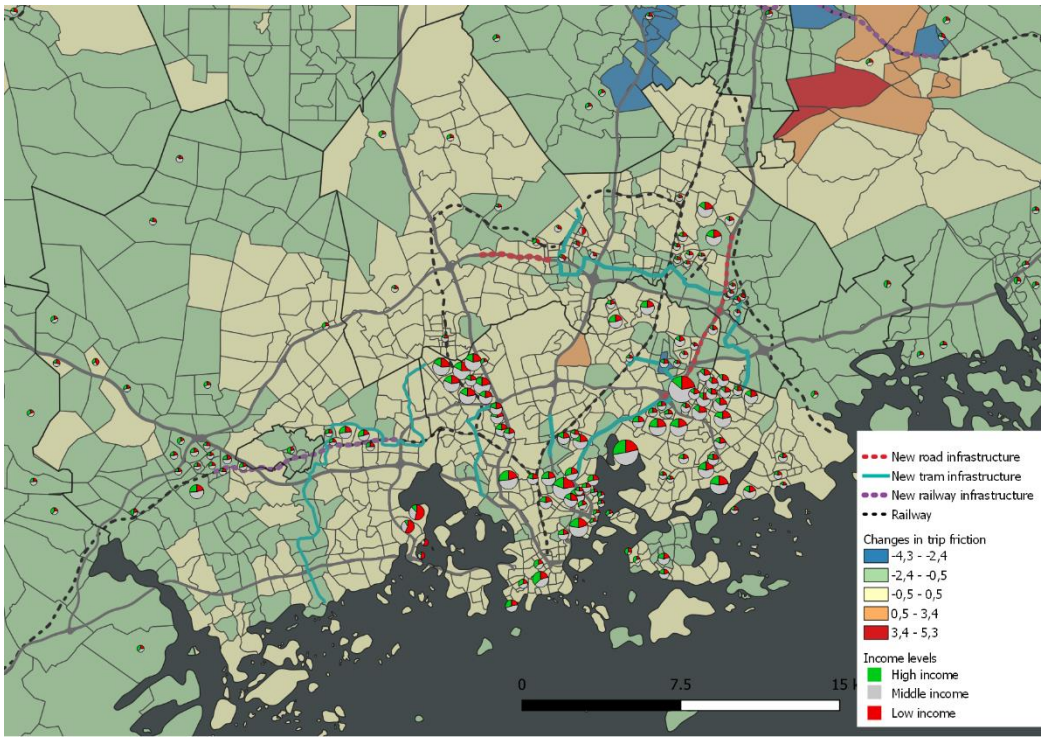

Figure 30. The change in generalized trip friction by public transport during morning peak hour in 2030 in the capital region and the areas where the percentage of residents of low income is 20 % or more.

The map visualization shows the distribution of income levels in the region. Areas, where the percentage of residents of low income level is 20% or more, are all over the region, but specifically in Espoo (Otaniemi, Espoon keskus), in Helsinki (Pohjois-Haaga, Kannelmäki, Kallio/Vallila, Rastila, Roihuvuori, Malmi, Jakomäki) and in Vantaa (Hakunila, Aviapolis, Tikkurila). These are areas where a high percentage of residents may have issues with affording transport costs. A positive notion is that, as the maps show, a large proportion of these areas are situated nearby current regional rail connections (e.g. Espoon keskus, Kannelmäki, and Malmi) or close to new proposed tram infrastructure in Malmi, Hakunila, (e.g. Viikki-Malmi tram and Vantaa tram). This indicates that a large part of the areas with higher low-income level stratification have decent opportunities for movement with sustainable modes of transport currently and in the future due to proposed MAL 2019 tram and railway projects. Many of the areas where some low-income level stratification exists are areas where large proportions of students reside, for example, Otaniemi and Vallila, who usually de facto have lower income level.

Nevertheless, in order to get a more analytical and a more comprehensive view on the distribution of costs and benefits of MAL 2019 plan on income levels, one must examine the data beyond just the map visualization. One way for this is to perform some simple calculations with excel. The way HELMET model is designed encourages the analysis of mean averages. The model itself forecasts the trip friction changes for each modelled zone by creating the trip friction total for total trips made to and from and in the zone for the two analysed scenarios. The model itself does not consider the income levels in its own forecasting. Therefore, it was decided that the income level distribution would be analysed by examining the mean trip friction change per trip for the average income level resident.

First, the change of trip friction was counted by subtracting the total trip friction for the alternative by the total trip friction for MAL 2019 plan for each zone. Second, the mean trip friction per trip by zone was counted by dividing the total change in trip friction per zone by the total number of trips made in and from the zone. This was counted for all the 1753 zones. Then, the total trip friction per each income level was counted by multiplying the mean trip friction per trip by the number of each income level resident on each zone. In the end, the total mean trip friction per trip per high income, middle income, and low income levels was counted by dividing the total mean trip friction per trip per each income level by the sum of all high income, middle income, and low income level residents respectively. The same calculation was done for the trip friction analysis results for passenger car traffic and for public transport and the results of workforce accessibility analysis on sustainable modes.

After calculating the mean trip friction change by public transport per trip for an average income level resident, one can see that the travel time reductions by public transport distribute very evenly on high income, middle income, and low income residents (figure 31) with only a 0,05 minute difference in between the middle income level compared to high income level and low income level in Helsinki region. The same can be seen while assessing the results for capital region, since the difference of mean travel time changes per trip between high income and middle and low income is only 0,04 minutes. The mean travel time changes by public transport distribute evenly to each income level also in Kuuma region with at most a 0,04 minutes difference in travel time changes between the income levels. This indicates that MAL 2019 plan distributes the benefits of changes in travel time by public transport evenly for the assessed income levels.

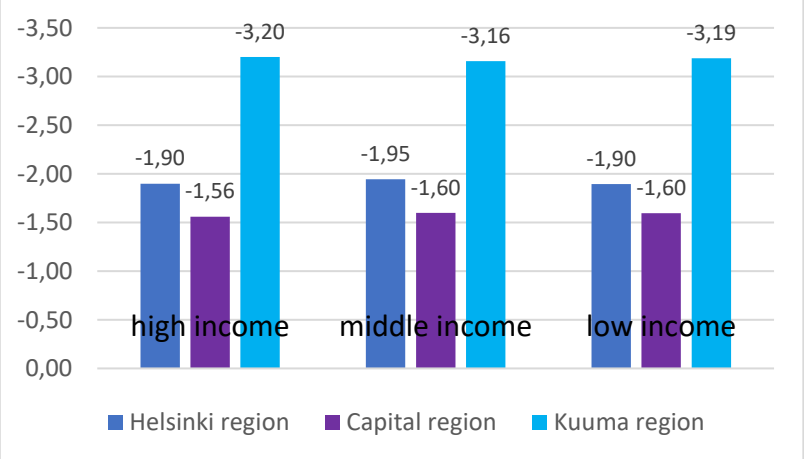

Figure 31. The mean change in travel times by public transport per trip (in minutes) on an average high income level, middle income level and low income level resident in Helsinki region, capital region, and Kuuma region.

While doing the same calculations for data gained from the analysis of workforce accessibility on sustainable modes of transport, the results show a very similar trend as with the distribution of travel time (figure 32). As for the whole Helsinki region, the analysis shows that the MAL 2019 plan distributes the changes in workforce accessibility on sustainable modes of transport evenly on different income levels. There are no

differences between the income levels while examining the the changes in workforce accessibility on sustainable modes in the capital region. A similar trend is seen in the Kuuma region, only a 0,01 difference on the change in accessibility between the high income level and the middle and low income levels. All in all, the change in workforce accessibility on sustainable modes is very evenly distributed on the different income levels in Helsinki region, capital region, and Kuuma region. The biggest distributional differences are spatial, not socio-demographic.

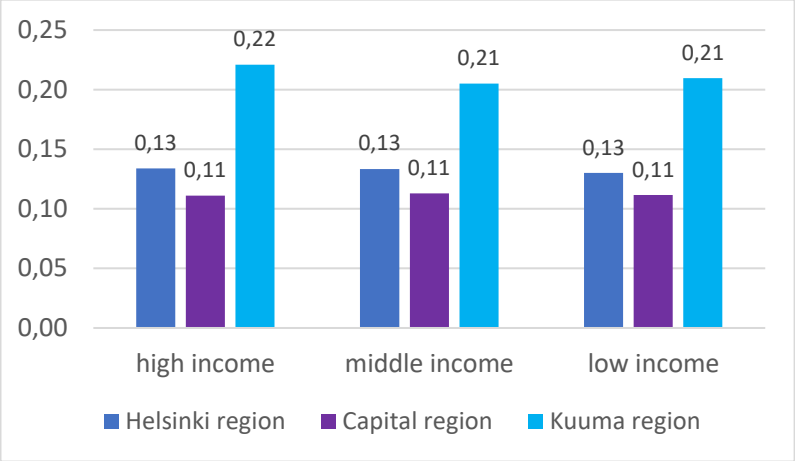

Figure 32. The mean change in workforce accessibility on sustainable modes of transport during morning peak hour in 2030 distributed on an average high income level, middle income level, and low income level resident in Helsinki region, capital region, and Kuuma region.

In addition, the changes in generalized trip friction by public transport distribute evenly on the region. Figure 33 shows that the differences in the distribution of benefits from the MAL 2019 plan on different income levels are small and vary at most 0.02 €. The differences in distribution are bigger spatially than between the different income levels.

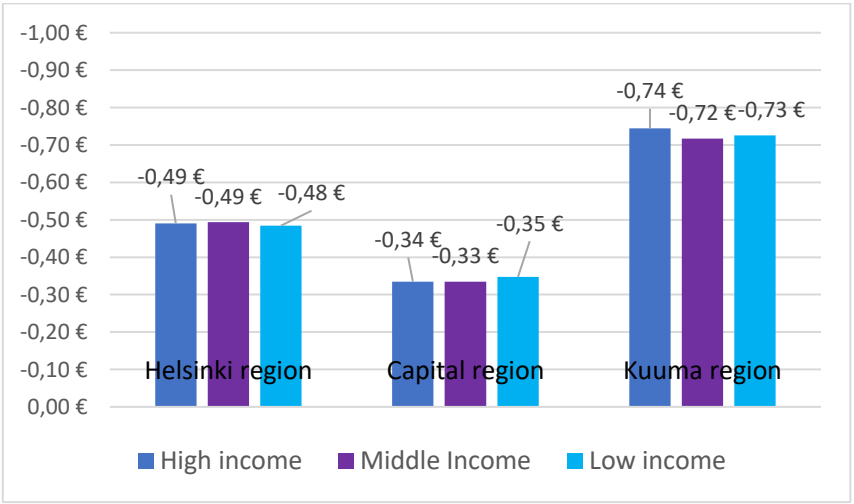

Figure 33. The mean change in generalized trip friction by public transport during morning peak hour in 2030 distributed on an average high income, middle income, and low income level resident in capital region, Kuuma region, and Helsinki region.

In conclusion, MAL 2019 plan reduces trip friction by public transport and increases the workforce accessibility on sustainable modes evenly on all income levels throughout the region. Therefore, the differences between the distribution of benefits and costs are evenly distributed. However, the differences in distribution are much higher when examining the distribution of costs and benefits spatially between capital region and Kuuma region since Kuuma region benefits from MAL 2019 plan more than the capital region. One explanation is that the baseline for trip friction and workforce accesibility in capital region and Kuuma region had disparities in the begin with, therefore, Kuuma region has more to gain from MAL 2019 plan since the baseline for trip friction and workforce accessibility was not compatible with capital region in the first place. In this case, the MAL 2019 plan benefits more the areas which were presented with more costs from the transport system to begin with.

There are a few explanations for the even distribution of the benefits of MAL 2019 plan on income levels. First, there are no significant distribution differences in Helsinki region since the region is just not that segregated according to income levels. In other words, the areas of Helsinki region are somewhat mixed so that individuals from different bakcgrounds live in all areas. Second, the data on income levels was already divided into the three classes (high, middle, and low income) which did have detailed data on residents of very low income but not on residents of very high income. The high income threshold was only 30 897 euros per year of disposable monitary income which is a bit higher than the median annual income per person in Finland. If the income level categorization would have been more elaborate and would have included more income level classes, the results may have been different since perhaps the very wealthy do not live in the same areas as the very poor. Third, MAL 2019 is a comprehensive plan which does distribute benefits on public transport and on sustainable modes to all over the region. Especially residents of low income benefit from the plan since a large number of residents of low income level already live along railway lines or will live when the future connections are built. Fourth, if this thesis were to study the other alternatives that were used in MAL 2019 impact assessment process, which all did not have the same listing of rail and tram infrastructure projects, the results could have shown more variation.

It is noteworthy that the even distribution of benefits between income levels will concur only if the planned infrastructure projects are implemented. It is not certain that all the infrastructure projects are actually built since MAL 2019 is just a plan, not a binding agreement. The implementation depends on the currently negotiated MAL agreement between the municipalities of Helsinki region and the state.

In addition, the discussed even distribution does not mean that the distribution is *equal* from the viewpoint of equity. The research did not proportion MAL 2019 impacts on trip friction by public transport and workforce accessibility on sustainable modes of the income levels to, for example, an average income level. Since the value of time and value of money differs between income levels, the proportioning would help to adjust the differences so that the relationship between the income levels could be properly

examined. If the proportioning were to be done, the distribution of costs and benefits could be seen as regressive (low income level residents benefit less than others). This viewpoint was acknowledged during the research, however, it was decided that this particular analysis were to be discarded for now.

All in all, it can be said that MAL 2019 plan measures enable an even distribution of benefits for income levels. MAL 2019 plan measures also benefit the areas that were previously more disadvantaged than the ones that were already more well-off. In a way, MAL 2019 plan incorporates the Rawlsian difference principle while distributing the plan benefits spatially, but not necessarily on income levels.

5 Discussion

This thesis set out to research the social and distributional impacts of transport in the Helsinki region's context. This section answers to the research questions presented in the introduction and discusses the design of the social impacts of transport assessment matrix, and the distributional impact assessment checklist. The case study will be considered in section 5.2 with a discussion on the results. The discussion considers also the used methodology and the recommendations for the future impact assessment process.

5.1 The social and distributional impact assessment framework

The social and distributional impacts of transport are a less analysed set of transport-related impacts. The analysis of social and distributional impacts of transport stems from a larger approach which considers transport from a comprehensive, social dimension. This approach derives from a multidisciplinary background of multiple methods, theories, and practices. It involves disciplines such as psychology, transport economics, human geography, transport planning, sociology, and even public health to mention a few (Jones and Lucas 2012).

The objective of this research was to recognize the social and distributional impacts of transport and understand the topic in the context of Helsinki region in order to further develop and support transport system impact assessment to include the analysis of social and distributional impacts. For this purpose, a social impact assessment matrix for strategic regional transport system planning was designed. The matrix highlights the topics which were seen the most important in the regional context, the most useful from a practice point of view, and topics that the HSL can study with current assessment methods. The tacit knowledge of the Helsinki region's context, the understanding of the usefulness, and the knowledge on HSL's current methods was gained from a regional workshop, the thesis steering group, and other discussions with HSL experts. The matrix is designed specifically for strategic planning; hence, some topics were discarded which were seen to serve the planning practice better on a detailed planning level.

Nevertheless, the practice should keep in mind that even the impacts that were better fitted for assessment on a more detailed planning level are important to remember on the strategic planning level and while planning Helsinki region's next MAL plan. Helsinki region's MAL is an important tool which can steer the planning on even the more detailed level to better include the assessments of social impacts of transport. Even if MAL planning cannot itself assess, for example, the barrier effects of infrastructure projects, it can still say that these impacts should be considered more thoroughly. In addition, MAL planning should remember that even though some impacts were not seen as systemic and broad in nature currently, this can change over time, as in the case of forced relocation due to infrastructure projects. Additionally, this research only focused on the known social impacts and the known unknowns (impacts that are known to be more unknown such as impacts of intrinsic travel), however, there might still exist some unknown unknowns which are currently still unrecognized. This means that practice should keep an open view

on the social dimension and keep in mind that perhaps all the aspects were not recognized in the current process.

Additionally, a distributional impact assessment checklist was designed to highlight the different stratifications individuals may have which can impact their travel and, as such, transport system comprehensively. The checklist was designed to highlight different distributional impacts; however, the checklist is not meant to be taken as a given. The different distributional aspects which should be assessed may differ case by case. Therefore, the checklist works as a reminder that individuals are not simply users of certain transport modes but do have many layers that need to be recognized in transport planning. The planners can use the checklist to see which distributional aspects are most important in relation to certain social, economic, or environmental impacts, and decide which aspects are important in the case at hand.

5.2 The case study on the distribution of costs and benefits

The research involved a case study which demonstrated the assessment of social and distributional impacts of transport by analysing the impacts of MAL 2019 plan on trip friction by public transport and on workforce accessibility on sustainable modes of transport. The analysis included the examination of how these impacts are distributed on different income levels and spatially. The results showed that the MAL 2019 plan reduces trip friction by public transport and increases workforce accessibility on sustainable modes almost everywhere in the region. This is due to the MAL 2019 plan's comprehensive rail and tram infrastructure project listing which enables more regional rail and tram connections throughout the region, and due to the implementation of cordon-based road tolls which decrease congestion and improve the traffic flow for also sustainable modes.

The assessment on the distribution of the benefits of MAL 2019 show that the benefits of accessibility and trip friction distribute evenly amongst different income levels in the Helsinki region. There are few explanations for the even distribution. First, the region is not so segregated so that different income levels would live on different areas. Second, the population data on income levels was not comprehensive enough to show the possible spatial residential differences of income levels. Third, MAL 2019 is utterly comprehensive with multiple infrastructure projects for sustainable modes which are distributed all around the region, therefore, the differences are distributed evenly on income levels as well. Fourth, the analysis only incorporated MAL 2019 plan and one alternative. If there were more comparisons made with other alternatives, there could have been more differences in the distribution.

The difference of distribution is much higher spatially between capital region and Kuuma region than on income levels. The difference is explained by the fact that Kuuma region has more to gain from the plan since the baseline of accessibility on sustainable modes and public transport trip friction is quite low. Even small improvements on accessibility and trip friction seem much higher since the baseline is much lower than on capital region.

5.3 The assessment of methodology

The thesis used change-oriented research design science approach as the overall research methodology (Straatemeier et al. 2010). The thesis process utilized the experiential learning cycle thoroughly, since the results of the thesis where modified and altered repeatedly after gaining feedback from the experts of the region and the HSL. The social impact assessment matrix, distributional impact assessment checklist, and the case analysis have been modified multiple times. The experiential learning cycle took place in workshops and steering group meetings where the then current thesis results were presented to and tested by the experts. The experts, in addition, gave the thesis process concrete planning experience. This resulted in observing and reflecting on what had been done and then adapting and altering the analysis further. (Straatemeier et al. 2010.) Therefore, the change-oriented research design science approach enabled the improving of the thesis and the advancement of the impact assessment development process itself. Perhaps this method also enabled the designing of the matrix and checklist to be too practice-oriented, however, the aim of the research was to develop practice and, therefore, the design needs to consider the needs of the planning practice.

The analysis used in the case study accompanied the Helsinki region's transport model HELMET, QGIS for visualizations, and some statistics analysis. The method for analysing the distribution of MAL 2019 benefits spatially and on income levels was successful. The HELMET model is designed for spatial assessments, therefore, the analysis worked quite well while assessing spatial distribution. Nevertheless, HELMET model lacks detailed analysis in order to incorporate a comprehensive assessment of the distribution on income levels. HELMET model is designed to analyse mean averages. Therefore, in its essence it is unable to analyse a more detailed group of travellers, such as income levels, or at this moment it is unable to do so. This effects the whole analysis. The model does not consider the different mode choices of different income levels and it does not consider the different trip assignment of income levels (HSL 2019c). For example, if the mean overall accessibility of sustainable modes were to improve all over the Helsinki region due to infrastructure projects, this does not mean that accessibility would improve for certain specific routes of certain income levels since individual travel patterns do not fall into mean averages. In addition, the value of time in the HELMET model changes only according to the trip purpose (e.g. work-based trip) (HSL 2019c). Hence, the value of time and the value of money are the same for all income levels. The generalized trip friction analysis incorporates the value of time and it is considered the same for all income levels, however, in real life this is most likely not the case. This does hamper the analysis.

In conclusion, the HELMET model does not give answers to changes in accessibility and trip friction of detailed socio-demographic groups. However, it does give answers to the mean averages of the socio-demographic groups. If the Helsinki region were more socially segregated and people of different income levels were living in separate areas, the results of this research could show the differences of distribution of the benefits and costs on income levels. Also, if the MAL 2019 plan were less comprehensive and the benefits were distributed only on certain areas of the region, this would most likely be present in the results since certain stratification of low income level residents does occur on specific areas where the plan currently does point infrastructure projects to. If MAL 2019 would

not propose infrastructure projects on areas of low-income level stratification, the results may have been different.

5.4 Ways forward

The thesis designed the social impact assessment matrix and the checklist for the assessment of distributional impacts. The thesis also demonstrated a way to assess the changes in accessibility and trip friction on different income levels. The question remaining is how the transport system planning practice can develop the assessment further and what should be considered still. The recommendations for the future steps are divided based on short and long-term development, and future research ideas.

5.4.1 Short-term development ideas

The recommendations for short-term development ideas involve aspects of organizational learning, suggestions for impact assessment methodology and organization, and suggestion for target setting.

Since the assessment of social and distributional impacts of transport stems from a multidisciplinary field of study, the impact assessment practice should also incorporate the expertise of multiple disciplines. *A multidisciplinary impact assessment steering group* is essential to recognize all the important aspects related to the social dimension of transport. This should include obviously experts from the fields of land use, housing, and transport but also experts of demographics, sociology, and even psychology to incorporate the assessment of the transport-related socio-demographic groups. In addition, experts who are involved with issues of traffic safety issues and local pollution should join the steering group to include their specific knowledge on methodology and forecasting. The steering group can also work as a forum to distribute information on assessment methods, on current research, and on different data possibilities.

The planning practice should involve the assessment of both aggregate and distributional impacts. Examining aggregate impacts is important to understand the overall big picture of transport policy measures. For example, it is important to know the net benefits of a certain transport infrastructure project. Nevertheless, the assessment of distributional impacts is necessary to understand how transport policy measures affect different areas, during different times of day, and how the measures impact different individuals. These aspects are not currently assessed sufficiently.

The planning practice should also incorporate the assessment of socio-demographic distribution of impacts into Helsinki region's MAL impact assessment process. The assessment of socio-demographic impacts is important since individuals have many stratifications and are not solely users of certain travel modes. *The assessment should focus on the least advantaged groups who are the most vulnerable against the impacts of transport measures.* The need for the assessment of socio-demographic impacts is highlighted while examining, for example, the pricing of road transport which can create negative changes

in individual's social cohesion and mental and physical wellbeing. In order to prevent these changes, one must assess the distributional impacts on groups beforehand.

The social impact assessment matrix and the checklist of distributional impacts can seem quite broad still from a practice point of view. It might seem that there are too many aspects for the planning practice to assess and consider. Nevertheless, the next MAL planning process will set the focus of the assessment through the objectives that will be determined in the next planning cycle. Some objectives may be decided to be determinative which will steer the focus of the assessment of social impacts of transport even further. Since this study examined the aspects of equity and considered the distribution of benefits and costs (although not from a viewpoint of equity), the recommendation for determining objectives is to include *an objective about transport system equity*. This is important since a determined equity objective does better guarantee an equal distribution in the future. It also determines the definition of equity since currently the experts and the decisionmakers may have alternate views on the matter. The definition of an equity objective also enables equity assessments in the future MAL impact assessment process.

One aspect that could focus the assessment of distributional impacts further is *the use of personas*. Personas are mostly used in product and service design to define an archetypal user of the product (Cooper 1999). In transport system planning this could mean creating personas which incorporate the different socio-demographic and mobility behaviour features of the residents in order to ease the impact assessment process. The personas are usually designed based on profiles which incorporate the resources individuals have (e.g. financial or educational) and the general attitude individuals have comprising of values and perceptions. (Vallet et al. 2020.) The distributional impact assessment checklist already provides the distributional aspects that could be considered while designing these mobility personas. The personas would work essentially as a tool for the impact assessment of socio-demographic groups specifically, but it could also include temporal and spatial aspects. The personas are mentioned here as an impact assessment method, not as a means to communicate the MAL plan to residents.

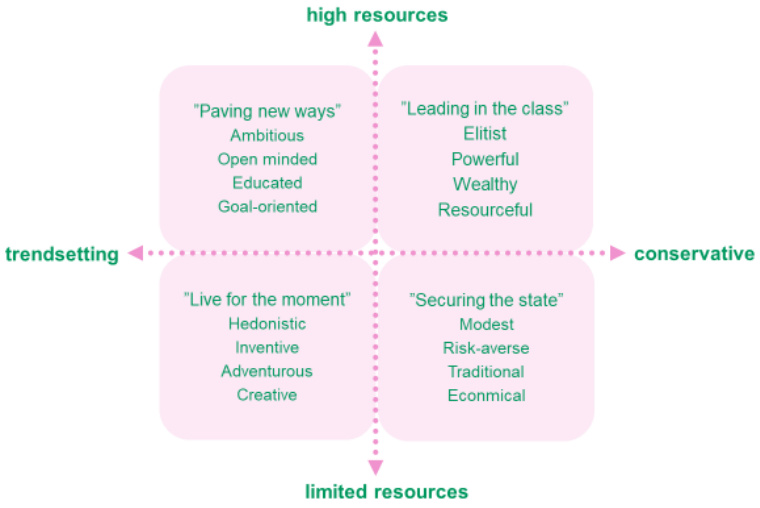

Figure 34. An example of mobility profiles which are used to design the mobility personas. Source Vallet et al. 2020.

5.4.2 Long-term development ideas

The long-term development ideas involve a suggestion on methodology and recommendations for organizational learning.

One aspect that would improve the assessment of distributional impacts is utilizing activity or agent-based models as the analysis method. As the name itself implies, agent-based models enable the analysis of individuals and different groups of individuals much more comprehensively than the currently widely used four step models which the HELMET model is (De Dios Ortuzar and Willumsen 2011). In the end, an agent-based model could even utilize the possibly constructed mobility personas as the background information for the model. However, this is a long-term development process which would take plenty of resources and as such is not possible for immediate impact assessment process development.

When it comes to impact assessments and their process, participatory planning processes are essential to include the views and ideas of the residents into the planning process itself. This is even more relevant in the context of social and distributional impacts since residents will most likely have more knowledge on the circumstances of an area and the impacts a plan may have on residents than the planners. The participatory process enables these views to be incorporated in the iterative planning process so that the views of the residents could be considered before the plan has been finalized. The recommendation is that the future impact assessment processes would enable more participatory methods, such as participatory spatial surveys on the impacts of future transport system plans. Since MAL planning aims at inclusion and co-operation, it is recommended that in the future planning rounds the resident participation is deepened further.

In addition, during the experiential learning process utilized in the thesis, the current transport system planning's organizational processes were also observed. One observation was that the planning could improve its organizational knowledge management since it turned out that planners did not always know what had already been examined in the previous planning cycles. This is most likely due to the enormous amount of information the MAL planning process produces and the hectic schedule in which the plan is designed in. The planners may not necessarily have time to digest all the information during the ongoing process. The planning practice would most likely benefit from an assessment of its own processes and an inventory of the current reports and research before the next planning cycle starts. This would steer the future planning cycle and give a comprehensive baseline on what the planning already knows and what information is still needed.

In an ideal situation the assessment of social and distributional impacts would provide information that would steer and enable a decision on which infrastructure projects or which transport policy measures to implement in the same way that a CBA does currently. Perhaps the assessment could at least steer the phasing of the infrastructure projects. However, there is still ways to go until this ideal is accomplished. The practice needs data, such as data on income levels from travel surveys, and methods, such as forecasting local pollution on a system's level. Some of the data needs can be answered with more back-

ground questions in travel surveys. The forecasting needs will require long-term development and co-operation between organizations, such as HSL and Helsinki Region Environmental Services Authority (HSY).

5.4.3 Future research

In the light of the thesis process and the academic knowledge and baseline gained from the topic, it seems important that accessibility would be studied further in the context of the Finnish transport sector. As it were discussed in the background section of the thesis, accessibility impacts the overall wellbeing of individuals since the lack of accessibility may result in social exclusion and lack of social capital (Shwanen et al. 2012; Stanley et al. 2012; Delbosc 2012). The research on social impacts of accessibility is mostly done outside Finland, although some preliminary studies have examined transport poverty (Tiikkaja et al. 2018). As stated, the relationship between accessibility and human wellbeing is known, however, it would be interesting to study further whether accessibility should be improved through increased public transport services (improved service level) or improved social welfare benefits (improved affordability). In addition, the Finnish transport sector could utilize information on how accessibility affects residents here in Finland. Since Finland has few cities, lots of smaller towns, and wide rural areas, the levels of accessibility vary enormously. In order to plan socially sustainable transport for all of Finland, it is essential to know the impacts of accessibility on residents in different areas. Future research on the social impacts of accessibility in Finland would be most welcome.

Furthermore, the transport planning practice in Finland would benefit from a more multidimensional understanding of the human mobility behaviour. Currently, the HSL requires information from mobility behaviour from the traffic survey which is implemented every four years (HSL 2019d). Similar survey is done on a national level approximately every six years (Liikennevirasto 2018). Nevertheless, this survey is a systems level survey which does not examine in depth why people choose to move the way they do. The psychological processes and societal practices which impact human mobility behaviour are not currently studied and analysed (Cairns et al. 2014; Chatterjee et al. 2019; De Vos 2017; Van Acker et al. 2010). Studying the multidimensionality of mobility behaviour would require more literature reviews, but most importantly more in-depth interviews of individuals and possibly more profound survey studies. Essentially, the planning practice needs to ask the people of their mobility choices and the reasons the behind them. The more profound understanding of the versatility of mobility behaviour is essential while the transport planning sector attempts to transform towards sustainability. Future research on the mobility behaviour would be a first step to incorporate the alternative viewpoints of mobility into planning practice and transport sector decisionmaking.

6 Conclusion

In an age of resource deficiency and an increasing need to rapidly reduce transport sector's CO_2 emissions, it is important to guarantee that the needed development in the transport sector is done in a socially sustainable manner. Therefore, the transport planning practice must consider all aspects of sustainable development: economic, environmental, and social sustainability. This requires understanding both the social and distributional impacts of transport and the multifacetedness of mobility behaviour.

This thesis focused on the social dimension of transport which included the examination of mobility behaviour, the social and distributional impacts of transport, and discussion on fair distribution and transport justice. It examined what are the social and distributional impacts of transport in Helsinki region's context, and how these impacts can be assessed on a strategic and regional planning level. The thesis incorporated a design of impact assessment matrices for the social and distributional impacts of transport in the Helsinki region's context. The matrices were produced in co-operation with HSL and Helsinki region's MAL planning experts.

In addition, the thesis included a case study which analyzed the distribution of spatial and socio-demographic impacts of MAL 2019 plan on accessibility and trip friction. The results of the case study showed that MAL 2019 plan benefits Kuuma region the most and distributes the benefits of the plan evenly among income levels. The case study demonstrated that the spatial and socio-demographic distribution of impacts can be analysed on the strategic planning level in Helsinki region. It also paved way for future analyses of the distribution of costs and benefits to be done in Helsinki region's context. The case study utilized Helsinki region's HELMET model, geographic information system QGIS, and geographic population data which are available also for future analysts.

The aim of the thesis was essentially to understand and consider the social and distributional impacts of transport so that the planning practice would be more equipped to answer to the future transport system planning challenges. The future planning practice needs to consider both the aggregate and distributional impacts of transport. This means that analysing the distribution of the benefits spatially, temporally, and socio-demograhically is equally as important as analysing the aggregate net benefits. When assessing the socio-demographic distribution of impacts, the focus should be on the least advantaged and vulnerable groups.

This thesis has focused on the systems level while examining and analyzing the social and distributional impacts of transport. The contradiction of analyzing *the social* from a systems level has been noted during the research albeit this was steered by the research questions. Nevertheless, to create sustainable change in the transport sector, the practice needs to also understand and consider the human perspective of transport. This means recognizing human mobility behavior not only from a neoclassical economic perspective, but as a multifaceted habit formation based on individual's inner psychological processes, the societal transport practices and the meanings of different transport modes, and the possibilities and limitations created by the built environment. It also means analyzing how transport measures impact groups and individuals and how the costs and benefits of transport measure are distributed. Planning is said to be done for the people. It is time to incorporate the people in the planning.

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Annex

Annex 1. The infrastructure projects of MAL 2019 plan for 2030 time frame (in Finnish). 2 pages

Annex 1. The infrastructure projects of MAL 2019 plan for 2030 time frame (in Finnish)

Jatkuvat kehittämisohjelmat

- Liikenneinfran pienet parantamishankkeet (KUHA) 300 M€ (30 M€/vuosi)
- Pyöräliikenteen pääverkko 200 M€ *
- Helsingin raitioliikenteen kehittämisohjelma 60 M€
- Helsingin seudun pääväylien liikenteenhallinta 20 M€
- Liityntäpysäköinnin toimenpideohjelma80 M€ *
- Meluntorjunnan toimenpidepaketti67 M€ *
- Raskaan liikenteen palvelualueet20 M€

  *Voivat toteutua osittain tai kokonaan KUHA-kokonaisuudessa

Pikaraitiotieverkon kehittäminen

- Mellunmäki-Tikkurila-Aviapolis-Lentoasema 260 M€
- Vihdintien pikaraitiotie Pohjois-Haagaan48 M€
- Viikin-Malmin pikaraitiotie200 M€
- Tuusulanväylän pikaraitiotie Käskynhaltijantielle25 M€
- Matinkylä-Suurpelto-Kera-Leppävaara182 M€

Raskas raideliikenne

- Rautatieliikenteen toimintamallit ja pienet infratoimet
- Pisararadan liikennöintisuunnitelman ja ratasuunnitelman tarkistus
- Metron kapasiteetin varmistaminen
  - Metron kääntöraide Matinkylässä 100 M€
  - Metron automatisointi 226-277 M€
- Espoon kaupunkirata Leppävaara-Espoo230 M€
- Pasila - Riihimäki kapasiteetin parantaminen 2. vaihe 273 M€
- Lähijunaliikenteen seisontavarikot (Päärata ja Rantarata)50 M€
- Vyöhykeliikenteen kalustoratkaisut (LVM)
- Rautatieliikenteen kulunvalvontajärjestelmä ERTMS taso 2
- Valmius aloittaa Pisararadan rakentaminen

Liittymät, jotka edellytyksenä maankäytön kehittymiselle

- Malmin lentokenttäalueen yhteydet (Tattarisillan liittymä, Kehä I ja Lahdenväylä)93 M€
- Kuninkaantammen eritasoliittymä ja Hämeenlinnanväylän lisäkaistat 45 M€

- Kehä I Maarinsolmu ja Hagalundin tunneli46 M€ + tunneli
- Lisäksi pienempiä maankäytön kehittymistä edistäviä liittymiä KUHA-hankkeina

Tieverkon kehittäminen

- Kehä III toimivuus (välillä Askisto - Pakkala)40 M€
- Lahdenväylän (Vt 4) lisäkaistat Kehä III-Koivukylänväylä 15 M€
- Lahdenväylän (Vt 4) lisäkaistat Koivukylänväylä-Kulomäentie18 M€
- Keski-Uudenmaan logistiikan poikittaisyhteydet
    - 1. vaihe Järvenpää – kt 4540 M€
    - Kehä IV –tason yhteyden (mt 152) suunnitteluvalmiutta edistetään